PB 227 357

STUDY OF REUTILIZATION OF WASTEWATER RECYCLED THROUGH GOUND WATER VOL. II

Doyle F. Boen, et al

Eastern Municipal Water District
Hemet, California

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27 *Abstract*

A project to demonstrate the feasibility and safety of recycling water under operating conditions was performed in the Hemet-San Jacinto Valley of the State of California. Since the Valley is a closed basin, and is dependent in part upon imported water, it was felt that recycling of the water would ultimately lead to a reduction in the salt input and resultant degradation of the existing underground reservoir.

Extensive geological investigations indicated that the basin was not homogeneous in nature, but had clay lenses and faulting which interfered with the creation of a classic mound. Partially as a consequence, the recharge of 5,380 acre feet of wastewater during this six and one-half year period had no effect on surrounding water wells.

The project added considerable knowledge and experience to the technology of intermittent wastewater percolation and associated monitoring techniques. A novel feature of the project was the employment of highly sensitive temperature probes to trace the lateral migration of the recharged water, much of which appears to be escaping as shallow underflow to the San Jacinto River and hence not reaching the deep groundwater table.

This report was submitted in fulfillment of Project Number 16060DDZ, under the partial sponsorship of the Office of Research and Monitoring, Environmental Protection Agency.

Abstractor	*Institution*

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STUDY OF
REUTILIZATION OF WASTEWATER
RECYCLED THROUGH GROUNDWATER

Volume II

BY

Doyle F. Boen
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Robert J. Currie

Eastern Municipal Water District
Hemet, California 92343

for the

OFFICE OF RESEARCH AND MONITORING
ENVIRONMENTAL PROTECTION AGENCY

Project 16060 DDZ

July, 1971

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APPENDIX NO. 1

GEOPHYSICAL INVESTIGATION OF THE SAN JACINTO VALLEY

GEOPHYSICAL INVESTIGATION OF THE SAN JACINTO VALLEY, RIVERSIDE COUNTY, CALIFORNIA

for

EASTERN MUNICIPAL WATER DISTRICT
HEMET, CALIFORNIA

by

JOHN D. FETT AND ASSOCIATES
26745 MERIDIAN STREET
HEMET, CALIFORNIA
DECEMBER 1967

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ABSTRACT

The subsurface geology was investigated in the San Jacinto valley of Riverside County, California by geophysical methods to understand better a segment of the San Jacinto fault zone and the bedrock configuration. Bedrock is sufficiently shallow beneath the southwest portion of the valley to be the major factor controlling ground water conditions.

A gravity survey was successful in determining the bedrock topography beneath the southwest side of the valley where bedrock depth is generally less than 1,000 feet. The drainage patterns on the buried bedrock surface are plotted for the southwest side of the valley.

Because of great depth to bedrock on the northeast side of the valley and lack of knowledge of the bulk density of the deeper sedimentary rock, the gravity survey yielded only qualitative findings on this side of the valley. A seismic refraction survey was then conducted to determine quantitatively the bedrock depth on the northeast side of the valley. Beneath this side of the valley, faulting has dropped bedrock to a depth of about 8,000 feet. This rift is bounded on the southwest by the Casa Loma fault, which passes through the center of the valley, and on the northeast by the Claremont fault, which forms the northeast edge of the valley.

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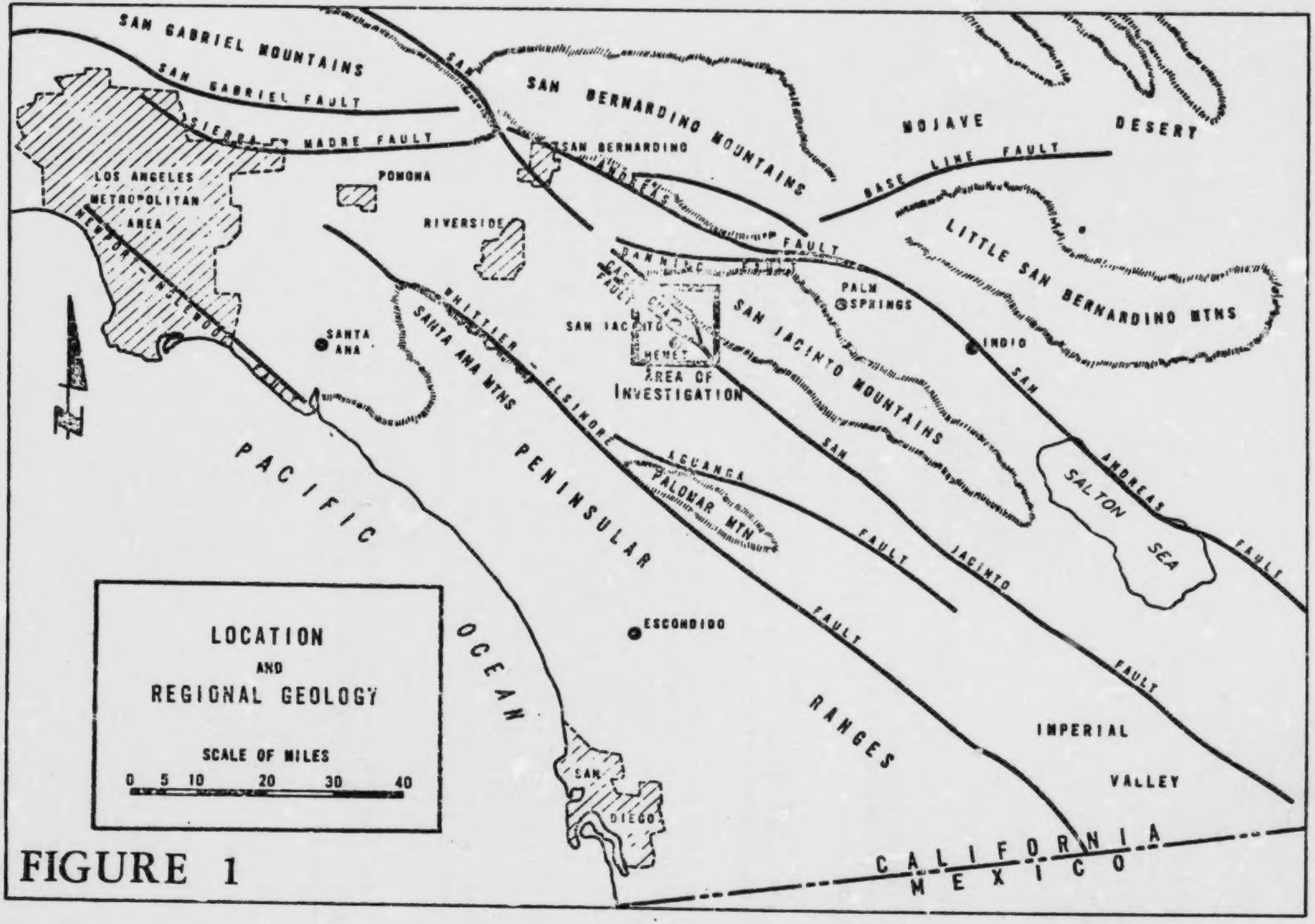
INTRODUCTION

The San Jacinto fault is one of the most active faults in Southern California. This report presents a gravity and seismic survey conducted along a portion of the San Jacinto fault zone near the cities of San Jacinto and Hemet, Riverside County, California.

A brief discussion of the geology of the area of investigation will be presented to assist in understanding the subsurface information obtained from the geophysical work.

The gravity survey was effective in outlining the buried bedrock topography on the Hemet side of the San Jacinto Valley where depth to bedrock is generally less than 1,000 feet. On the San Jacinto side of the valley, depth to bedrock was found to be in excess of 3,500 to 4,000 feet and difficult to accurately determine gravimetrically. The gravity work did indicate the location of the deepest portion of the valley and this location was the first to be seismically investigated. The finding was a one and one half mile depth to bedrock in the three mile wide graben formed by the Casa Loma and Claremont branches of the San Jacinto fault zone.

Illuminated by the geophysical findings, the ground water geology and engineering geology of the valley will be discussed in the last section of the report.


SAN GABRIEL MOUNTAINS
SAN GABRIEL FAULT
SIERRA MADRE FAULT
SAN ANDREAS FAULT
SAN BERNARDINO MOUNTAINS
SAN BERNARDINO
MOJAVE DESERT
BASE LINE FAULT
LITTLE SAN BERNARDINO MTNS
LOS ANGELES METROPOLITAN AREA
NEWPORT - INGLEWOOD FAULT
POMONA
RIVERSIDE
SANTA ANA
BANNING FAULT
CASA FAULT
SAN JACINTO
HEMET
AREA OF INVESTIGATION
PALM SPRINGS
INDIO
SAN JACINTO MOUNTAINS
SAN JACINTO FAULT
SALTON SEA
WHITTIER - ELSINORE FAULT
SANTA ANA MTNS
AGUANGA
PALOMAR MTN
PENINSULAR RANGES
ESCONDIDO
PACIFIC OCEAN
SAN DIEGO
IMPERIAL VALLEY
CALIFORNIA
MEXICO
SCALE OF MILES
0 5 10 20 30 40

LOCATION AND REGIONAL GEOLOGY

FIGURE 1

GEOLOGY

REGIONAL GEOLOGY

Figure 1 indicates the regional geology and the location of the area of investigation.

The area of investigation is at the northern end of the Peninsular Range. Obliquely traversing the Peninsular Range are several parallel fault zones trending northwest-southeast. The San Jacinto fault zone passes through the area of investigation. The San Andreas fault zone is to the northeast and the Elsinore (Whittier-Elsinore) fault zone is to the southwest. On the basis of seismicity in historical time, the San Jacinto fault zone is perhaps the most active in southern California (Allen, et al., 1966). Between the San Jacinto and Elsinore fault zones is the Perris Block, a relatively stable geomorphic unit named by English (1926) and its geomorphology described by Dudley (1936). The Hemet side of the San Jacinto valley is on the edge of the Perris Block and the San Jacinto side of the valley is on the San Jacinto fault zone.

A rift or graben, bounded by the Casa Loma and Claremont branches of the San Jacinto fault system (figure 2), exists beneath San Jacinto.

A similar structure exists in the Elsinore fault zone. A lava flow, probably of late Pliocene or early Pleistocene age, has been dropped at least 3,000 feet by faulting and covered by more than 2,400 feet of graben filling sediments, (Mann, 1955).

LOCAL GEOLOGY

The geologic relations in the area are largely controlled by faulting. Alluvium has been deposited against faulted blocks. To the southwest of the Casa Loma fault, alluvium has been deposited against remnant high points of metamorphic and igneous rocks. The alluvium itself has been cut by faults, some forming escarpments at the surface. Other faults are indicated by anomalous ground water conditions. Figure 2 is a map of the local geology generalized by the writer from the state geologic map (Rogers, 1965). Figure 3 presents bedrock elevations determined from well logs. The well data northwest of Hemet are from Bean (1955); the remainder have been gathered by the writer. No wells have reached bedrock between the Casa Loma and Claremont faults in the area of investigation.

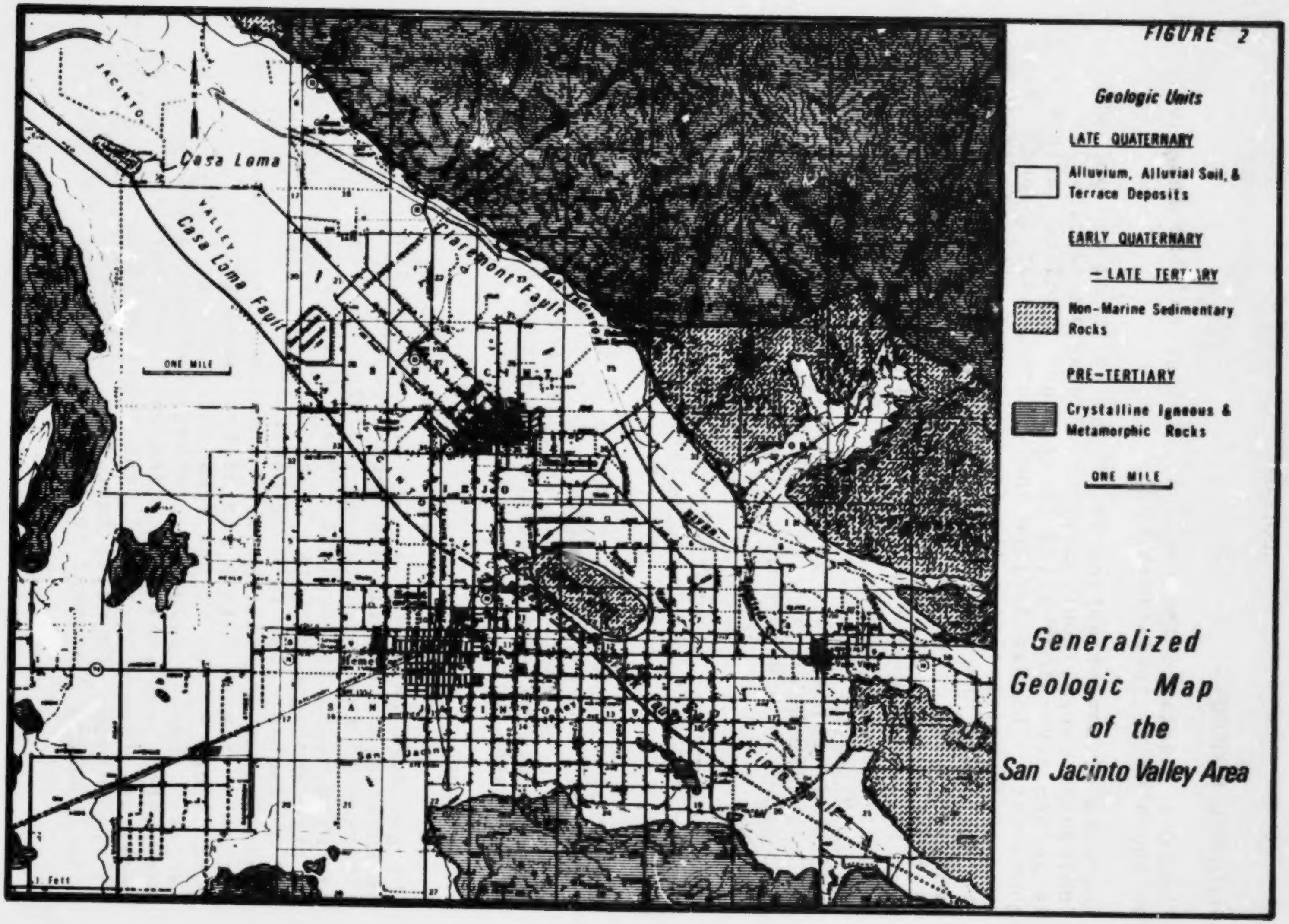


FIGURE 2

Generalized Geologic Map of the San Jacinto Valley Area

Geologic Units
LATE QUATERNARY
☐ Alluvium, Alluvial Soil, & Terrace Deposits
EARLY QUATERNARY — LATE TERTIARY
▨ Non-Marine Sedimentary Rocks
PRE-TERTIARY
▨ Crystalline Igneous & Metamorphic Rocks
ONE MILE
Casa Loma
VALLEY
Casa Loma Fault
Claremont Fault
JACINTO
SAN JACINTO
ONE MILE

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Geologic Formations

The metamorphic rocks are mostly schists and gneisses. They have been assigned to the Paleozoic Era by Larsen (1948).

The igneous rocks are mostly Cretaceous tonalites and granodiorites. These plutonics are part of the southern California batholith and are described by Larsen (1948).

Since the densities and especially the seismic velocities of the metamorphic and igneous rocks are similar, these rocks are not differentiated on the generalized geologic map. Both may be considered as impermeable, nonwater-bearing rocks, though for small water supplies the greater fracturing and depth of weathering in the metamorphics tend to make them more productive than the igneous rock.

The early Quaternary - late Tertiary sediments of the area were named by Frick (1921) and divided by him into the Mt. Eden, San Timoteo, and Bautista Formations. Based on vertebrate faunas he assigned them to the Upper Lower Pliocene, late Pliocene and Pleistocene, respectively. They are all poorly consolidated continental clastics, generally of rather low permeability. These older sediments form Park Hill, Casa Loma, the hills east of Bautista wash, the Badlands to the northwest of the area of investigation, much of the Soboba reservation, and the sediments of the southwest side of the San Jacinto mountains.

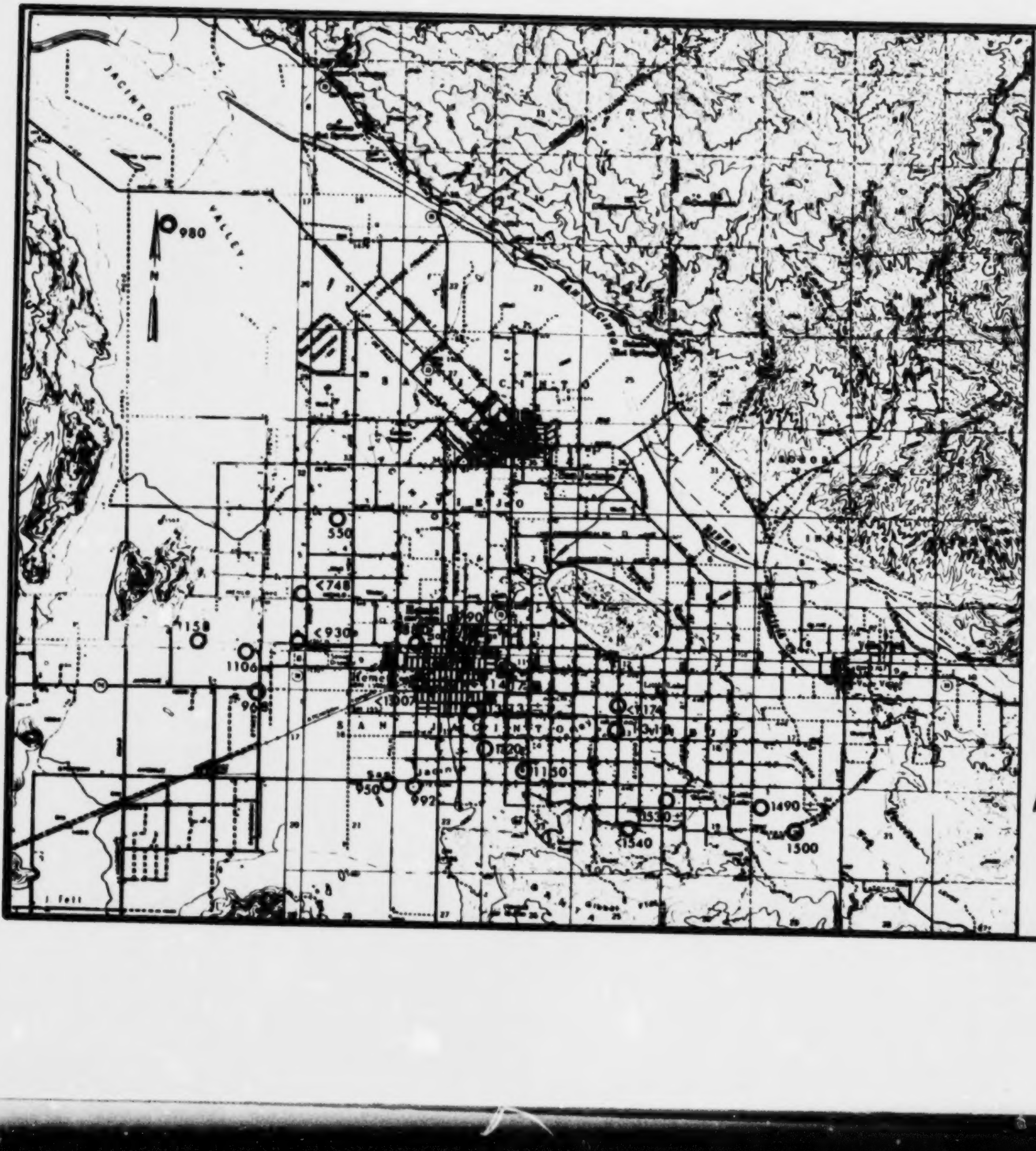
The recent - late Pleistocene sediments fill much of the San Jacinto valley and most are stream channel deposits. Some thin silt and clay layers were deposited by flooding and contemporaneous weathering increased the content of the residual clay.

Faults

The Casa Loma fault forms the northeast boundary of the Perris Block in the area of investigation. A recent scarp exists along this fault, extending from Casa Loma to Park Hill. It has a maximum height of over 20 feet, the northeast side having dropped relative to the southwest side.

Trenches across this fault were dug for the Los Angeles and San Diego branches of the Colorado River aqueduct and these excellent exposures of the fault's recent activity were described by Buwalda (Bean, 1955) and by Proctor (1962). The fault hampers the flow of ground water; differences of as much as 50 feet in the water table have occured across the fault immediately west of Park Hill.

FIGURE 3


JACINTO
VALLEY
980
N
SAN JACINTO
RIVER
550
<748
<930
158
1106
968
<1307
1417
<1174
1120
1150
950
992
1530±
<1540
1490
1500

Bedrock Elevations From Well Log Data

ONE MILE

ELEVATIONS IN FEET ABOVE SEA LEVEL

To the south and southeast of Park Hill, Bean located a fault by geomorphic and hydrologic evidence. He named it the Bautista Creek fault. It has a scarp of a few feet to six feet in height, the northeast side having dropped relative to the southwest side. This fault has moved in the same sense as the Casa Loma and is well aligned with it. The writer suggests they are essentially the same fault. The segment of recent scarp southwest of Park Hill has been removed by erosion. Down-faulting of the area to the northeast of the fault formed a closed topographic depression between the fault scarp and Park Hill. Subsequent flooding and overflow caused the above-mentioned erosion of the scarp segment. Bean noted that the Bautista Creek fault meets the Casa Loma fault west of Park Hill but felt there are many dissimilarities between them. He cited the absence of a low scarp along the Bautista Creek fault in the alluvium and the lack of irregularity of trace in its exposures southeast of the valley. Hence he believed the Bautista Creek fault to have marked strike-slip movement as opposed to dip-slip movement on the Casa Loma fault. On the first point, Bean evidently did not notice the low scarp that does exist along a mile and a half of the Bautista Creek fault. If the Bautista Creek fault were to have a large dip-slip component in the San Jacinto valley, depth to basement would be much greater to the northeast of the fault and the gravity and seismic work investigated this question.

Bean continued the Bautista Creek fault to the southeast of the valley and when the faults southeast of the valley were later studied by Sharp (1967), Sharp called this same fault the San Jacinto fault.

On the north side of the San Jacinto valley the Claremont branch of the San Jacinto fault zone is located at the contact between the valley fill and the steep metamorphic and igneous mountains to the north (Fraser, 1931 and Bean, 1955). The mountains to the north have been elevated along this fault to 3,000 feet above the valley floor. Minimal erosion on the mountain face and extremely small alluvial fans at its foot indicate the recentness of this movement.

Near the center of the valley, Bean located the Park Hill fault along the north side of Park Hill and continued it to the southeast. He noted that it does not appear to have an effect on ground water in the recent sediments. The writer has seen no positive evidence of this fault and has omitted it from the generalized geologic map.

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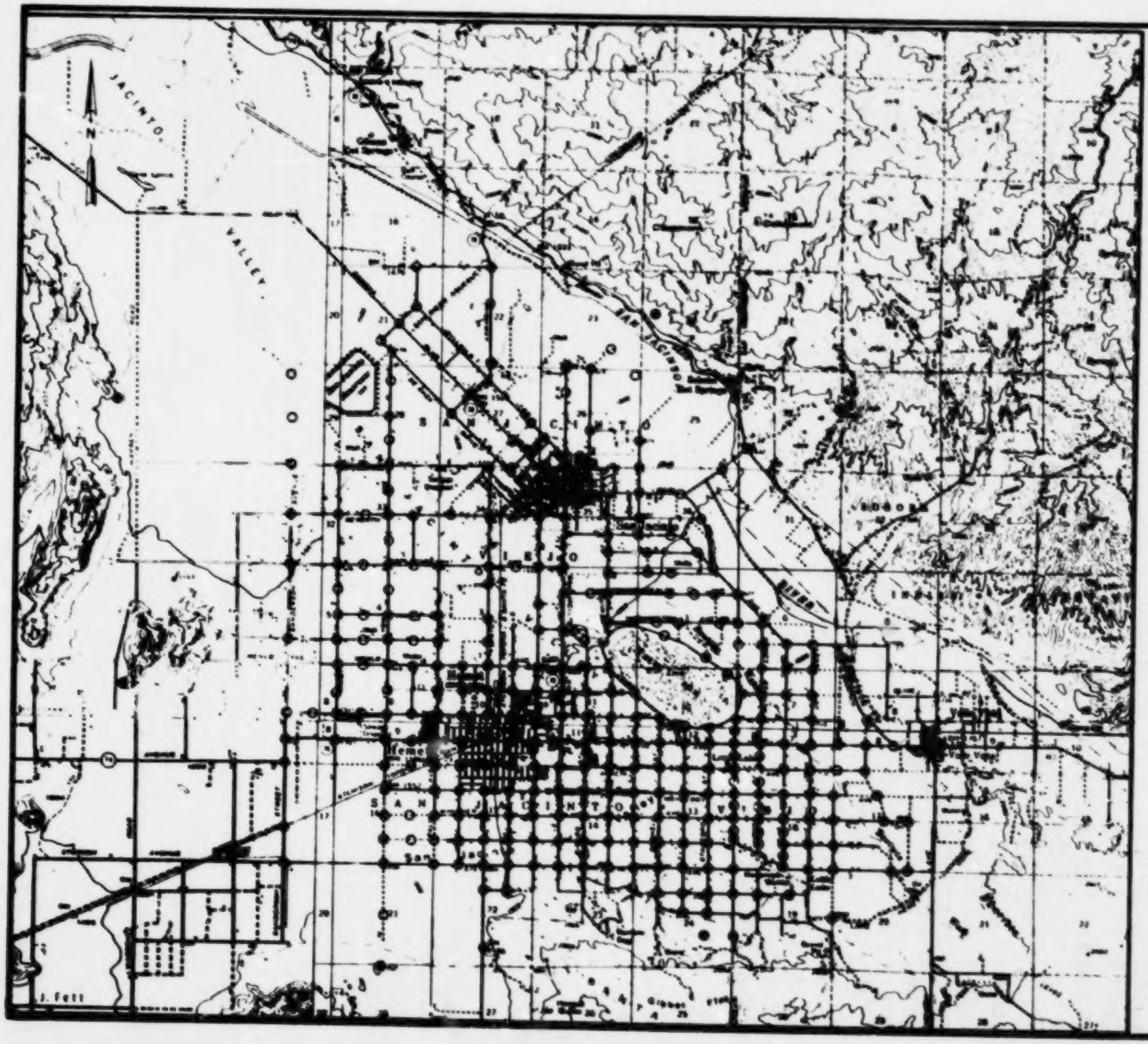
FIGURE 4


JACINTO
VALLEY
SAN JACINTO
SAN JACINTO
J. Fett

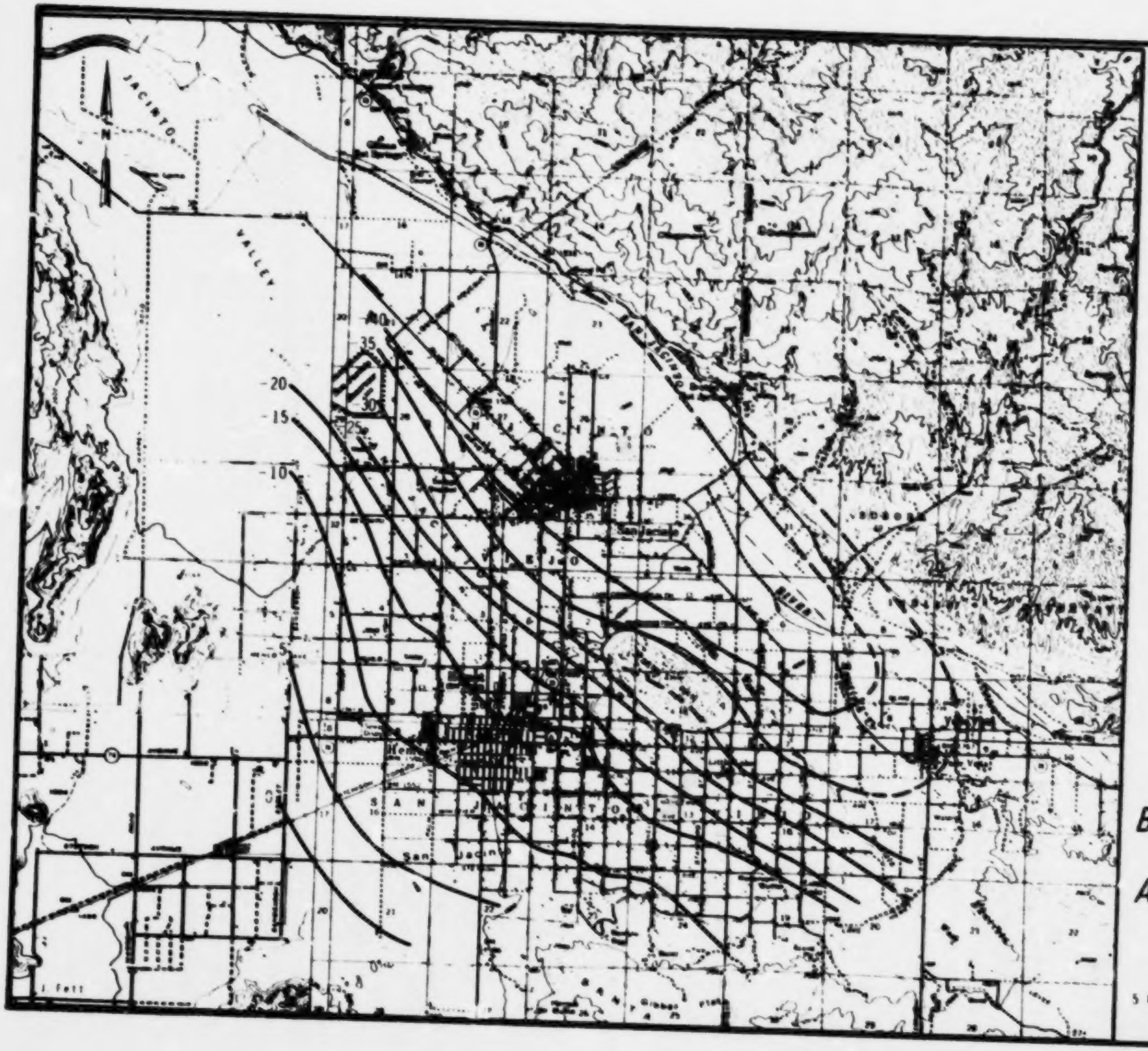
Location of Gravity Stations

ONE MILE

● Gravity Station On Bedrock

○ Gravity Station On Sediments

FIGURE 5


N
JACINTO
VALLEY
SAN JACINTO
RIVER
SAN JACINTO
San Jacinto
40
35
30
25
-20
-15
-10
-5
0

Bouguer Gravity Anomaly Map

ONE MILE

5 Milligal Contour Interval

Arbitrary Datum

Landslides

Numerous landslides have occurred in the Bautista sediments. Recent occurrences are mostly the result of embankment steepening by river erosion or faulting. Undoubtedly, movement of many of these slides has been triggered by earthquakes. Townley (1918) reported the occurrence of slides during the 1918 earthquake.

Subsidence

Three forms of subsidence are occurring in the San Jacinto valley.

Tectonic lowering of the graben bounded by the Casa Loma and Claremont branches of the San Jacinto fault zone has created a closed topographic depression north of the Lakeview mountains. Historically, the depression has been filled with flood water to form a dry lake (Waring, 1919).

Subsidence of approximately the same area has been taking place during the past thirty or so years as a result of ground water withdrawal (Fett, et al., 1967). The rate of subsidence is currently about 0.1 foot per year. Pipelines, roads, and structures at the edge of the graben are being damaged. Numerous water wells in the graben have failed by axial compression and many more will be destroyed (Fett and Hamilton, 1968). The size and depth of the natural topographic depression north of the Lakeview mountains is increasing due to this new subsidence.

On the Hemet side of the valley, soil collapse occurs beneath a portion of the City of Hemet. Soil possesses the potential hazard of collapse when it has been deposited so loose as to have sufficient void space to hold enough water for the soil's liquid limit to be reached (Gibbs and Bara, 1967). Wind-deposited silt is the probable local origin of these dangerous soils. No matter how small the foundation loading, if a structure's foundation does not extend below these soils, the structure will settle if the soil becomes saturated. This has occurred to several buildings in the City of Hemet and will probably damage more in the future. It is quite possible that these soils exist at other locations in the San Jacinto valley but have gone unnoticed because of sparce building development in the past.

GRAVITY SURVEY

The gravity survey used LaCoste and Romberg G-22 geodetic gravity meter. It is a portable, temperature-regulated meter working on the zero-length spring principle. It is characterized by small drift without tares.

The locations of most gravity stations of this survey are indicated on figure 4. Some additional stations were occupied outside the area of investigation to obtain insight into the regional gravity anomaly. Station locations, elevations, observed gravity, and anomalies are presented in tabular form in the appendix.

The gravity work presented here is only the writer's portion of a larger project conducted by Dr. Gordon P. Eaton and the writer. The gravity data of the larger project are being reduced in detail by electronic computer. The gravity anomalies plotted here have been reduced by desk calculator. The resulting Bouguer anomaly is presented in figure 5.

A small error has been introduced by ignoring the terrain correction. Most stations are on the rather flat valley floor. At these stations, the error introduced by ignoring the terrain correction for nearby topographic irregularities is negligible. At these stations, a larger error is introduced by ignoring the terrain correction for distant topography, such as the mountains north and east of the valley. This larger error is smoothly varying across the valley and most of this error will be removed with the regional anomaly.

The error introduced by ignoring the terrain correction for Park Hill was checked for the station nearest the hill and found to be less than 0.3 milligal.

In the area of investigation, the primary causes of the Bouguer anomaly are variation in the thickness of the valley filling sediments and variations in the thickness of the earth's crust. Since the crust is about thirty miles thick beneath the area of investigation, the regional anomaly produced by variation in the crust's thickness is very smooth compared to the anomaly produced by variation in the thickness of the valley sediments.

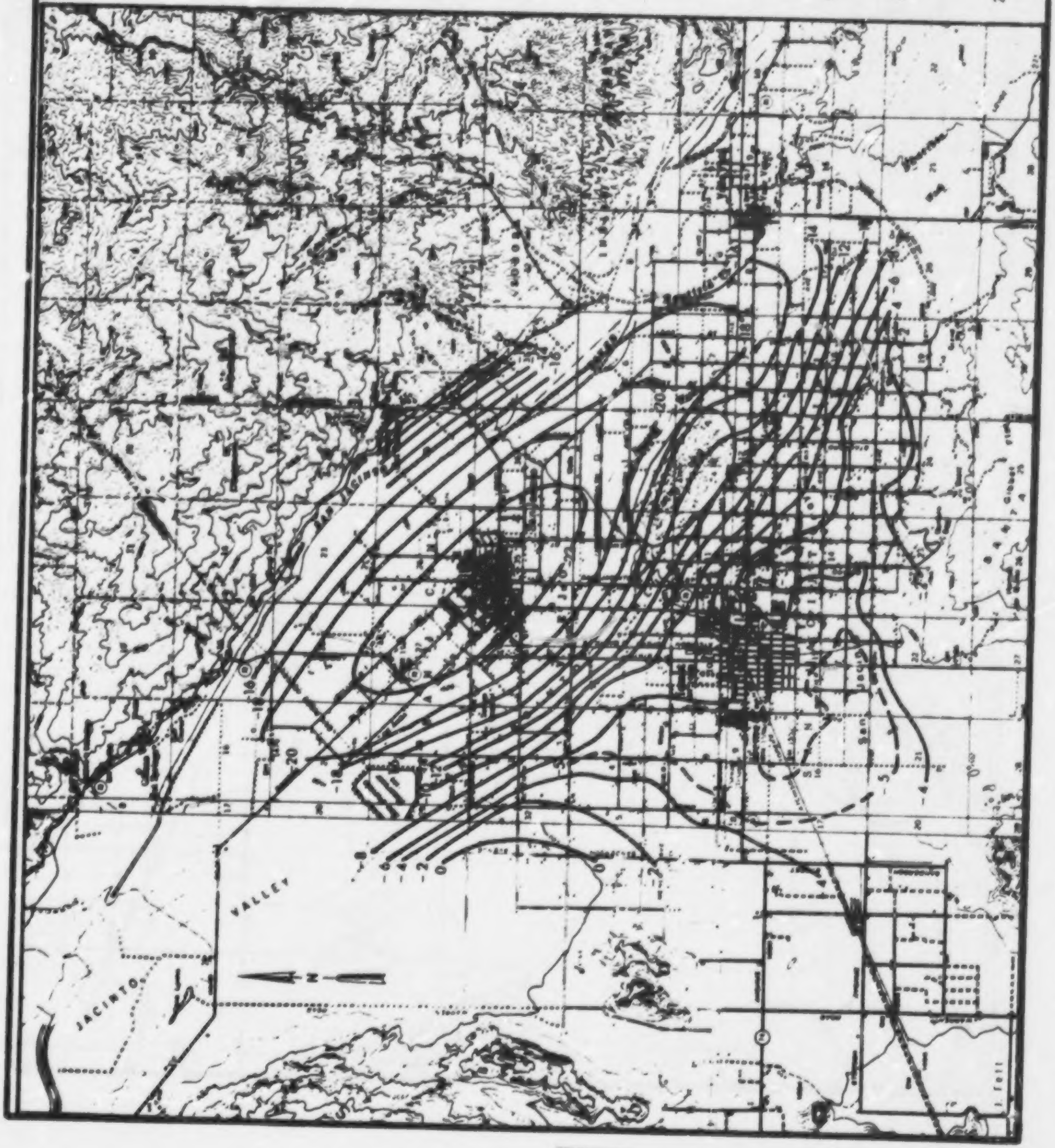
The anomaly caused by the valley sediments is of interest for this investigation. To extract this local anomaly, the regional anomaly must be removed from the total Bouguer anomaly. In this study, the regional anomaly has been approximated by a linear decrease in gravity, going from the southwest edge of the valley to the northeast edge. The magnitude of this decrease has been adjusted to yield a local anomaly that is approximately zero in value on bedrock on both sides of the valley. The resulting anomaly, figure 6, is due primarily to valley sediments. To the southwest of the Casa Loma fault, this anomaly is approximately proportional to sediment thickness.

To the northeast of the Casa Loma fault, the gravity anomaly indicates the deepest part of the valley to be approximately beneath the city of San Jacinto. At this location, the anomaly indicates sediment thickness of about 3,500 feet, if a density contrast of 0.5 is assumed.

With sediment depths of 3,000 feet or more, the gravity method of determining depth to bedrock becomes more qualitative than quantitative unless sediment bulk densities are known in detail. The local anomaly is caused by contrast between sediment and bedrock bulk densities. Sediment bulk density increases with greater depth of burial, approaching the density of bedrock. Also, some sediments in the San Jacinto valley have, in the geologic past, been buried to a depth greater than their present depth. Only sparse information is available on sediment bulk densities in the San Jacinto valley and none for depths greater than 1,000 feet.

The greater bulk density of the Bautista Formation sediments of Park Hill deflects the contours of the local anomaly (figure 6) in the vicinity of Park Hill. They would be deflected a slight (less than 0.3 milligal) additional amount if the terrain correction had not been ignored.

FIGURE 6


JACINTO
VALLEY
N

Bouguer Gravity Anomaly With Regional Removed

ONE MILE

2 Milligal Contour Interval

Arbitrary Datum

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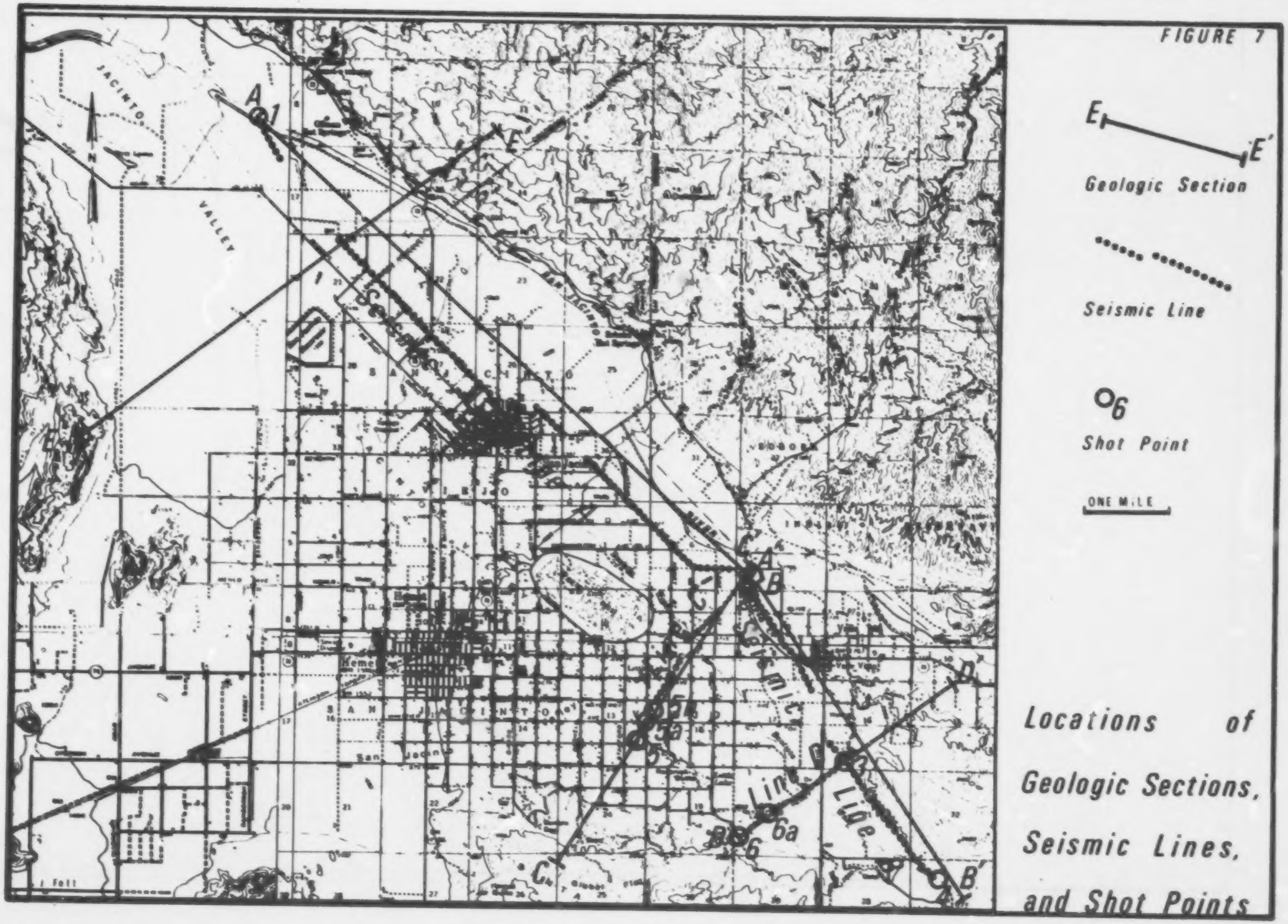
FIGURE 7


E
E'
Geologic Section
Seismic Line
6
Shot Point
ONE MILE
A
1
E
JACINTO
VALLEY
Seismic Line
A
B
C
5
5a
6
6a
B'
C'
SAN JACINTO
Hemet

Locations of Geologic Sections, Seismic Lines, and Shot Points

SEISMIC SURVEY

To determine more accurately the depth of valley filling sediments in the San Jacinto valley, a seismic refraction survey was conducted.

The seismic velocity of granitic bedrock in the area of investigation was first determined. This was accomplished by Dr. Eaton, University of California at Riverside (UCR) students, and the writer with the writer's Texas Instrument EXPLORER system. Measurements were made on the northeast side of the Lakeview mountains, both across foliation and along foliation. The rock was found to be anisotropic, with minimum velocity about 14,500 feet per second across foliation and maximum velocity about 17,000 feet per second along foliation.

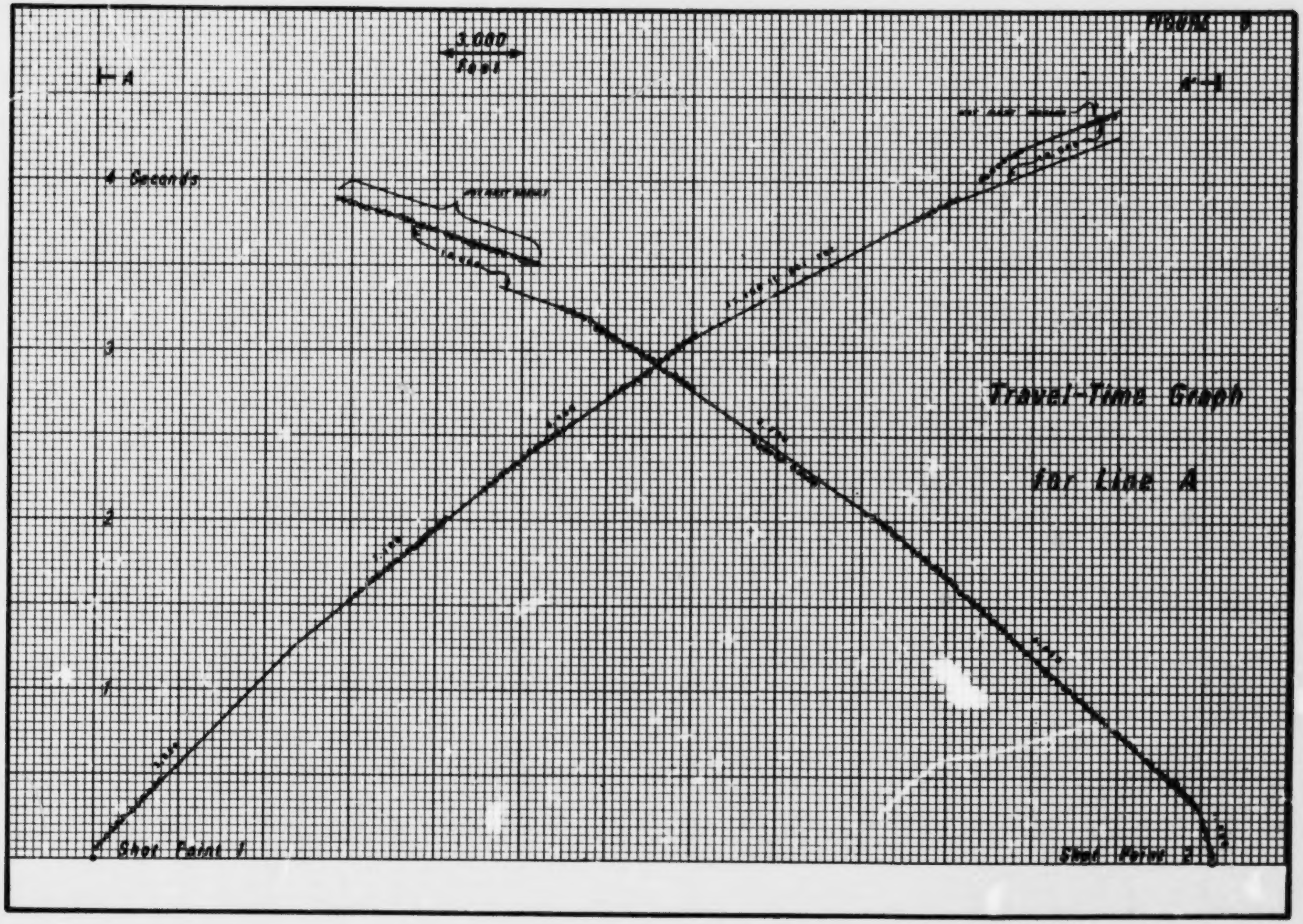
On two commercial seismic investigations in the area, the writer measured the seismic velocity of unweathered metamorphic bedrock and found 15,000 to 16,000 feet per second to be typical. The metamorphics displayed less anisotropy than the foliated granitics.

Line A

The first line profile, Line A, figure 7, was located along the axis of the gravity low with the City of San Jacinto at the center of the line.

Drs. Shawn Biehler and Stewart Smith of the California Institute of Technology, Dr. Gordon Eaton of UCR, students of both schools, and the writer performed the recording of Line A data from Shot Point 1. The shot point was at the northwest end of the line and was located in the San Jacinto riverbed just west of the junction of Massacre Canyon Creek with the river. The location of this shot point and the recording locations are plotted on figure 7. California Institute of Technology (CIT) personnel supervised operations at Shot Point 1. Shot instant was radioed to recording units by CIT's tone generating blaster. Several seconds before shot time a 400 Hz tone was transmitted. This tone was interrupted at the precise instant of cap detonation. The tone signal was received at recording units and placed on records by auxiliary galvanometers.

Eastern Municipal Water District (EMWD) supplied explosives and the men and equipment to place the charges for all seismic work. Dynamite was used for the explosive agent for Shot Point 1. Charge size increased as recording locations became more distant. Maximum shot size was a little in excess of 500 pounds.



To verify the findings of the above work and to determine the dip of the bedrock, Line A was reversed. The reversal was performed by Dr. Eaton and the writer, with the aid of UCR students. The writer's TI EXPLORER seismic equipment and tone blaster together with EMWD radio equipment were used for the reversal of Line A and all subsequent work.

The shot point, Shot Point 2, was at the southeast end of the line, in Bautista Creek, just north of Cedar Avenue. The location of Shot Point 2 is plotted on figure 7.

To economize on explosive costs, the writer instructed EMWD personnel in the use of ammonium nitrate - fuel oil explosive. This reduced explosive costs to about 18 percent that of conventional explosive.

Shot holes were dug with a back-hoe and the hole depth was limited to about 11 feet. To increase the efficiency of the explosive charges, no more than 120 pounds were placed in a single shot hole. When larger charges were needed, they were obtained by connecting two or more shot holes together with Primacord detonating fuse. Thus, more energy went into seismic wave generation and less into the air. This also had the effect of keeping the predominant frequency of the seismic pulse close to that desired for optimum transmission and recording. Cratering was also reduced. Subsequent to this field work, O'Brien (1967) published information on the efficient use of large charges.

Distance and travel-time data of Line A are tabulated in the Appendix and plotted on figure 8.

Line A Interpretation

CIT interpreted the unreversed data of Line A from Shot Point 1. The water table was interpreted to be 30 feet below the surface near Shot Point 1. The seismic velocity of the unsaturated sediments was 1,300 feet per second and the saturated sediments beneath the water table had a velocity of 5,500 feet per second. The velocity was interpreted as increasing to 7,350 feet per second at a depth of 830 feet. At a depth of 1,920 feet the velocity increased to 8,650 feet per second and at a depth of 5,400 feet it was interpreted as increasing to 10,150 feet per second. The bedrock was interpreted to be 10,400 feet beneath San Jacinto. There were no travel-time data recorded between 21,100 and 28,900 feet from Shot Point 1. The critical distance for the bedrock refraction appears to be about 29,700 feet from Shot Point 1. Figure 9 is the seismic recording on which the bedrock refraction appears to become the first arrival. There is some uncertainty in the above interpretation

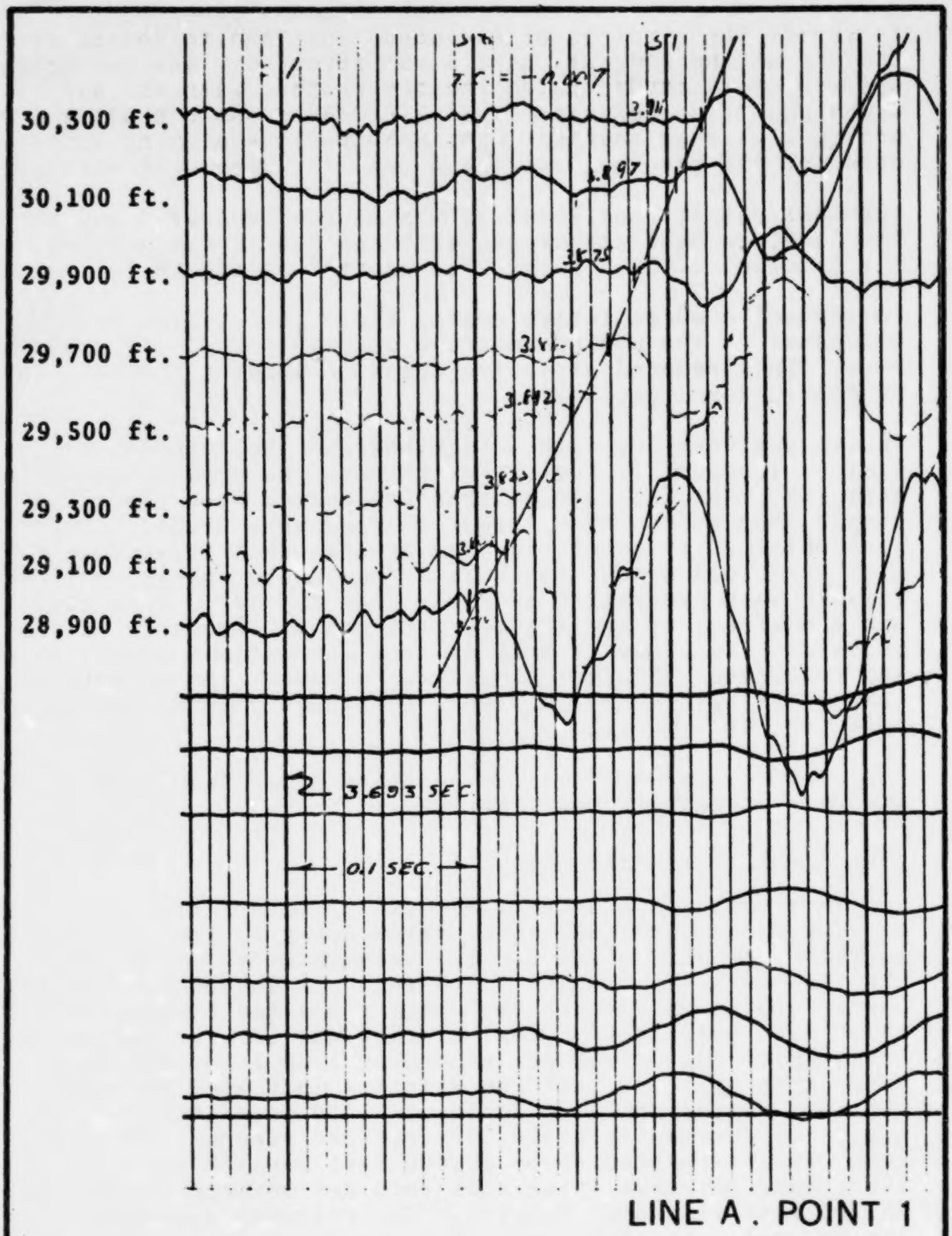


FIGURE 9. SEISMIC RECORD

because of the lack of data along almost a mile and a half of line and because of the possibility of the change in apparent velocity at 29,700 feet from Shot Point 1 being caused by irregularity of the water table. There are several large production water wells in the area east and southeast of San Jacinto.

The writer's interpretation of the unreversed Line A data from Shot Point 2 places the water table, in the vicinity of Shot Point 2, at a depth of about 200 feet. At a depth of about 2,200 feet a mile northwest of Shot Point 2, the velocity of the sediments increases to about 8,700 feet per second. The bedrock surface is about 7,800 feet beneath Line A approximately two miles northwest of Shot Point 2. These depths are based on a four layer model with velocities of 1,800, 6,650, 8,700 and 18,000 feet per second and critical distances of 550, 11,300, and 22,200 feet. Figure 10 is the seismic recording on which the bedrock refraction becomes the first arrival.

It seems likely that the 8,700 feet per second surface at a depth of 2,200 feet is the same surface as the 8,650 feet per second surface calculated by CIT to be at a depth of 1,920 feet approximately a mile and a half southeast of Shot Point 1. There are four and a half miles between these depth determinations. Since the elevation of Shot Point 2 is approximately 220 feet greater than that of Shot Point 1, the average dip of this surface between the depth determinations is approximately zero.

The two bedrock depth determinations are horizontally separated by about two and a half miles and the northeasterly determination is approximately two and a half thousand feet deeper than the southeasterly determination. A northwesterly dip of about 12 degrees could be inferred, but the recorded apparent bedrock velocities do not tend to confirm a northwesterly dip. The apparent bedrock velocity of 18,000 feet per second, from Shot Point 2, is rather well established. The apparent bedrock velocity from Shot Point 1 is not clearly determined. Line A at least indicates a minimum depth of about 8,000 feet beneath San Jacinto. Additional recording from Shot Point 1 to the southeasterly portion of Line A should clarify the above findings. There is a possibility that the bedrock refractions from Shot Point 1 are refractions from the side of the graben. The seismic interpretations are based on the assumptions that there are no hidden layers (Green, 1962) or velocity reversals. A perched water table in the vicinity of Shot Point 1 would tend to make the deeper refractors appear excessively deep.

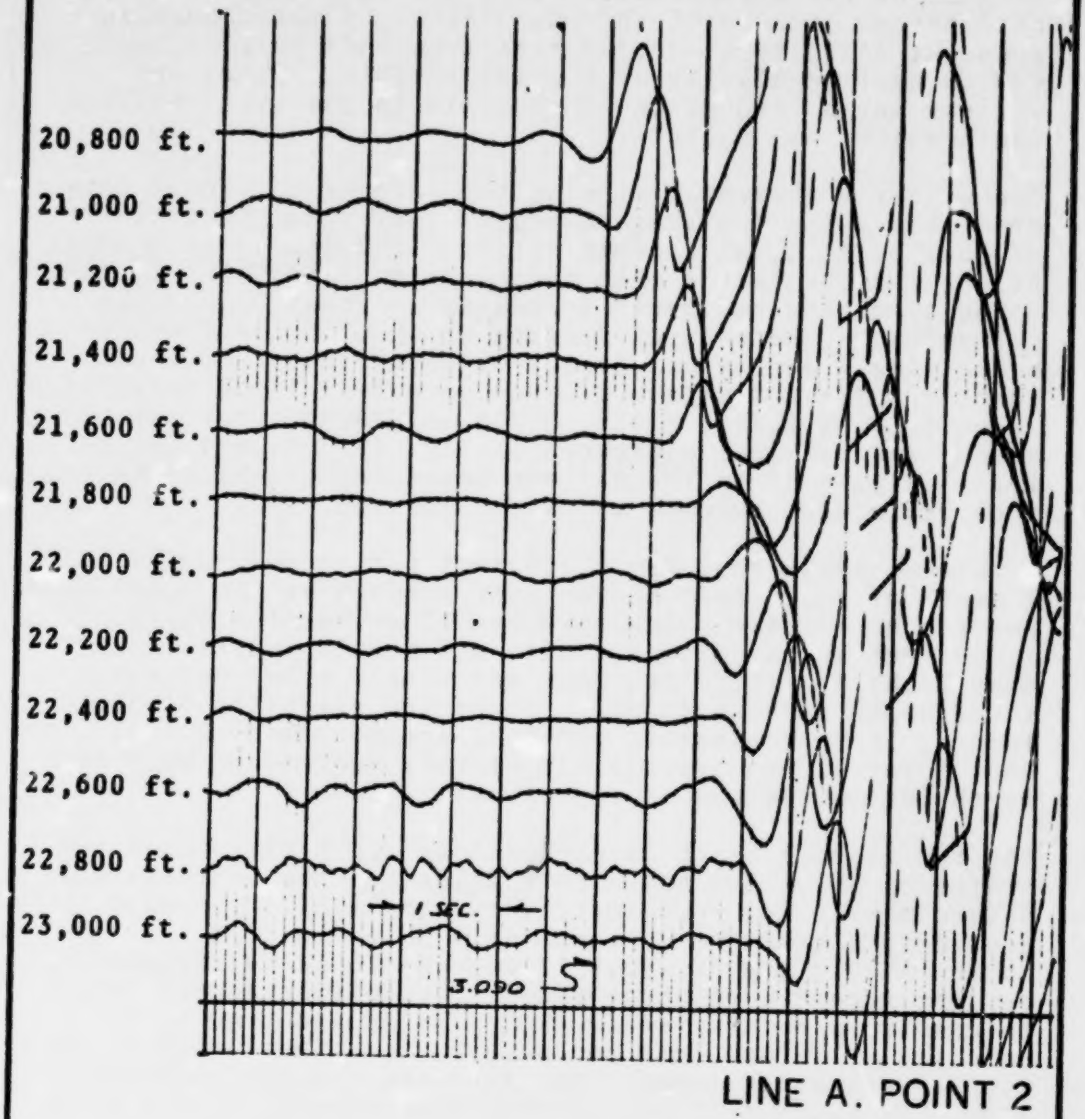


FIGURE 10. SEISMIC RECORD

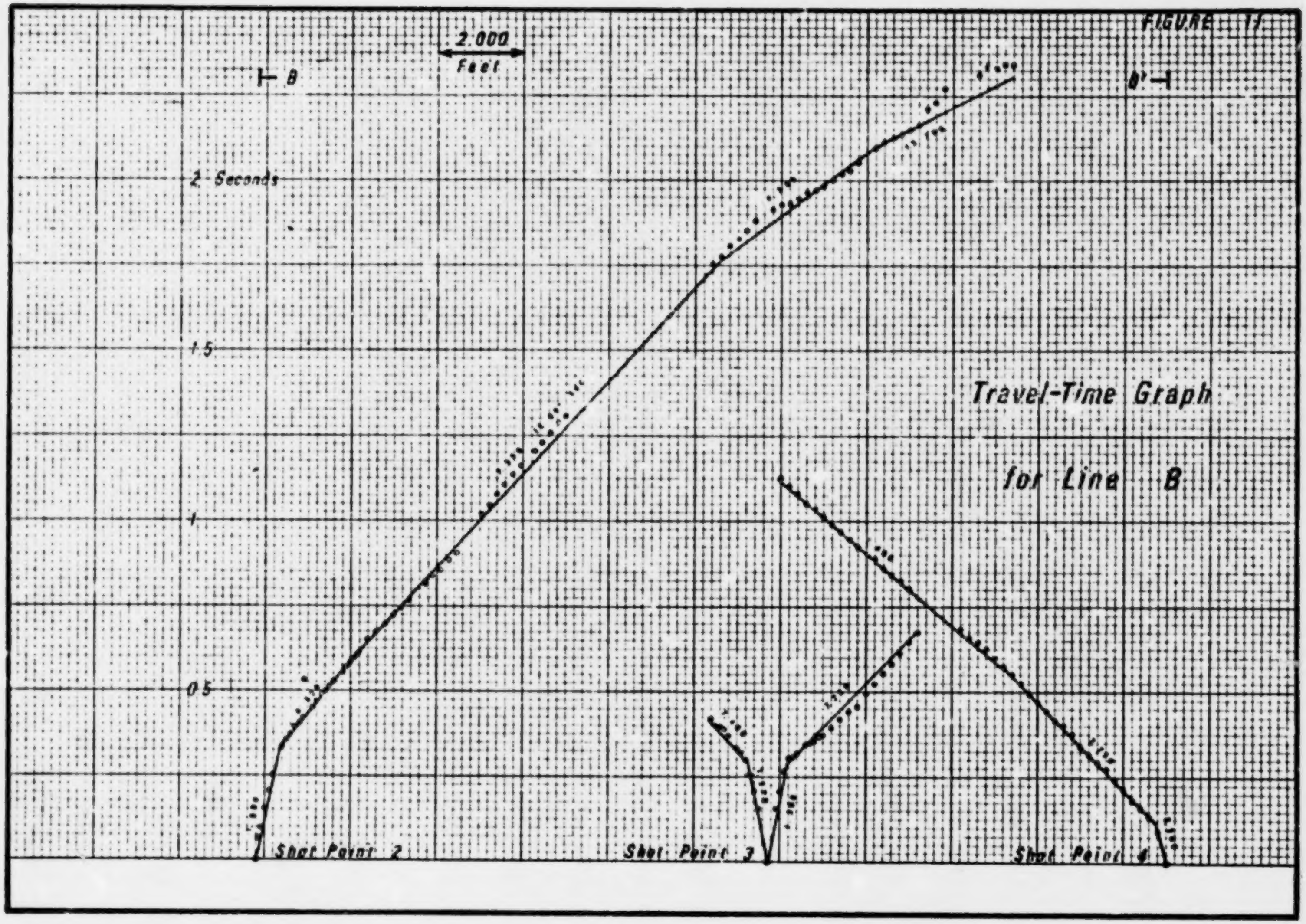
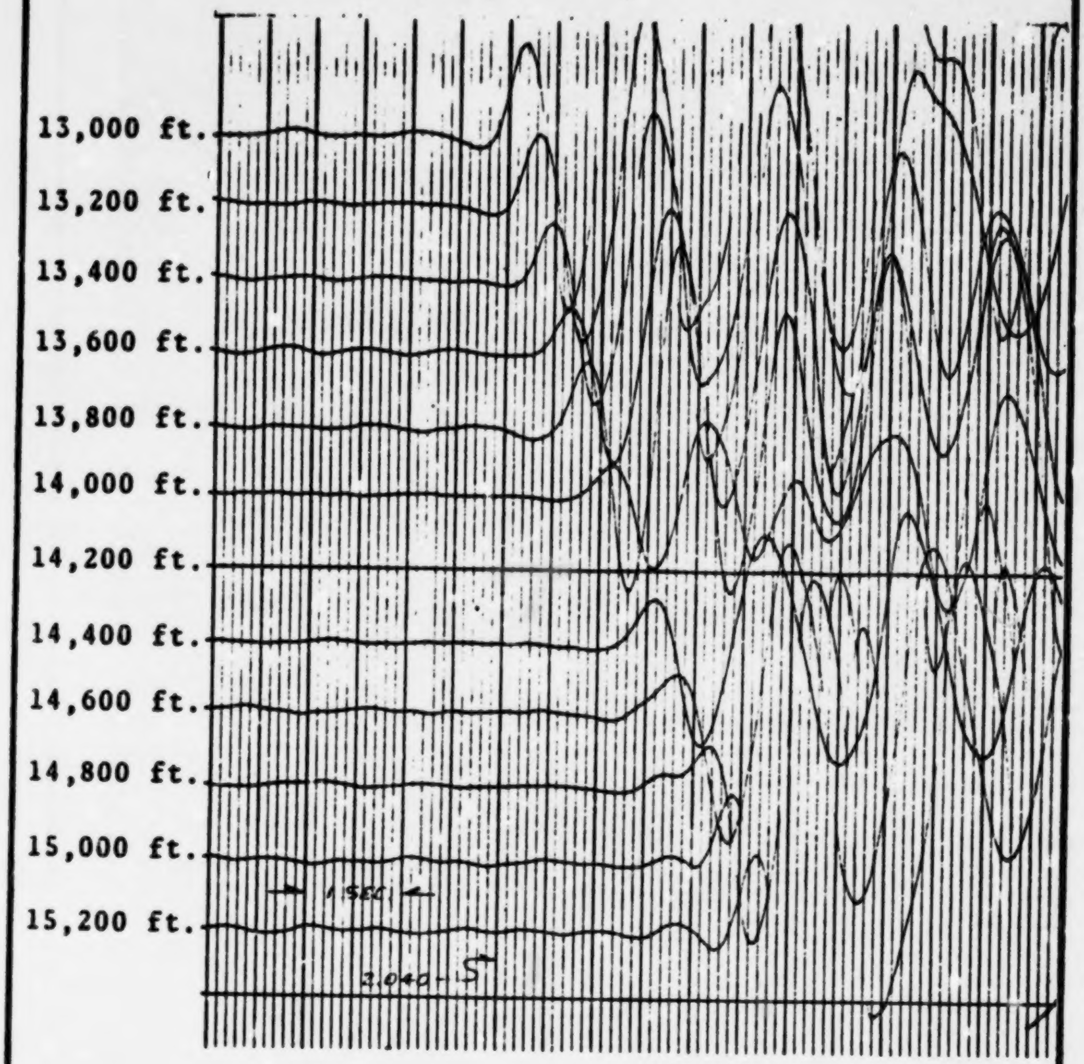


FIGURE 11

Travel-Time Graph for Line B



LINE B . POINT 2

FIGURE 12. SEISMIC RECORD

Having velocity information from the refraction work, reflection recording in the San Jacinto Valley should now be more feasible.

Line B

With the assistance of EMWD, the writer performed three more deep seismic profiles in the upper portion of the San Jacinto Valley.

Line B follows the Bautista Creek - Bautista flood control channel from Shot Point 2, near the junction of Bautista Creek with the San Jacinto River, through - Shot Point 3, to Shot Point 4 at the mouth of Bautista Canyon. The locations of Line B and Shot Points 2, 3, and 4 are plotted on figure 7. Except for Shot Point 2, size of charges was limited by cultural development. The distance and travel-time data are tabulated in the appendix and plotted on figure 11.

Line B Interpretation

Near the northwest end of Line B, the seismic data indicate a water table at a depth of 195 feet. A refractor of higher seismic velocity is indicated at a depth of approximately 485 feet beneath Line B, a quarter of a mile northeast of Shot Point 2. These depths are based on a three layer model with velocities of 1,600, 6,500, and 7,350 feet per second and critical distances of 500 and 2,400 feet.

Shot Point 3 is near the center of Line B. A few hundred feet northwest of Shot Point 3, the seismic data indicate the water table to be at a depth of 182 feet. This depth is based on a two layer model with velocities of 1,570 and 7,400 feet per second and a critical distance of 450 feet. A few hundred feet southeast of Shot Point 3, the seismic data indicate a water table at a depth of 185 feet. This depth is based on a two layer model with velocities of 1,500 and 7,750 feet per second and critical distance of 450 feet.

Near the southeast end of Line B, the seismic data indicate the water table to be at a depth of about 100 feet beneath the down-stream base of the Riverside County Flood Control dam. This portion of the seismic field work was performed in late April, 1967, and water depth behind the dam was about four feet. It is likely that the water table rapidly increased in depth to the northwest, (down-valley). The seismic data from Shot Point 4 also indicate a refractor with an apparent velocity of 9,600 feet per second at a depth of 660 feet below Line B about midway between Shot Points 3 and 4. These depths are based on a three layer

From Shot Point 2, no refraction from bedrock is observed until the Bautista Creek fault is approached. This is a distance of about 9,000 feet. If the bedrock beneath this segment of Line C has zero dip, the depth to bedrock would be in excess of 3,200 feet. This minimum depth seems consistent with both the geology and seismic Lines A and B.

These depths are based on a four layer model with velocities of 1,600, 5,900, 6,750, and 16,000 feet per second and critical distances of 550, 3,000, and 9,000 feet.

Near the southwest end of Line C, first arrivals from Shot Point 2 have an approximately infinite apparent velocity. One solution that would explain these arrivals and the seismic information from Shot Point 5, and be consistent with the geology is the following: waves from Shot Point 2, upon reaching the Bautista Creek fault, would be refracted up the bedrock face of the fault and then diffracted waves would radiate in all directions. Some would pass up through saturated sediments, be refracted at the water table and emerge, almost simultaneously, along a few hundred feet of Line C, to each side of the fault.

From the fault, the bedrock surface becomes shallower until it crops out at Shot Point 5. About 700 feet northeast of Shot Point 5, the data from Shot Point 5a indicate bedrock depth to be approximately 250 feet. A little further to the northeast, the sediment depth becomes sufficient for the water table to be encountered. From the water table to the fault, the bedrock surface must dip to the northeast at an angle of about 20 to 25 degrees to account for the low apparent velocity recorded from Shot Point 5. At the fault, the bedrock depth is approximately 800 feet.

The available data could also be explained without a fault. This alternate solution would be a bedrock surface dipping to the northeast at an angle of about 22 degrees. This dip would account for both the infinite apparent velocity at the southwest end of Line C from Shot Point 2 and the apparent velocity of 8,700 feet per second from Shot Point 5. This dip calculation is based on a bedrock velocity of approximately 16,000 feet per second and a saturated sediment velocity of approximately 6,000 feet per second.

Though the alternate solution also fits the seismic data of Line C, it does not seem a likely solution from the geologic point of view. The question could be resolved by extending the seismic recording from Shot Point 5 further to the northeast or by reflection recording a quarter of a mile northeast of the Bautista Creek fault.

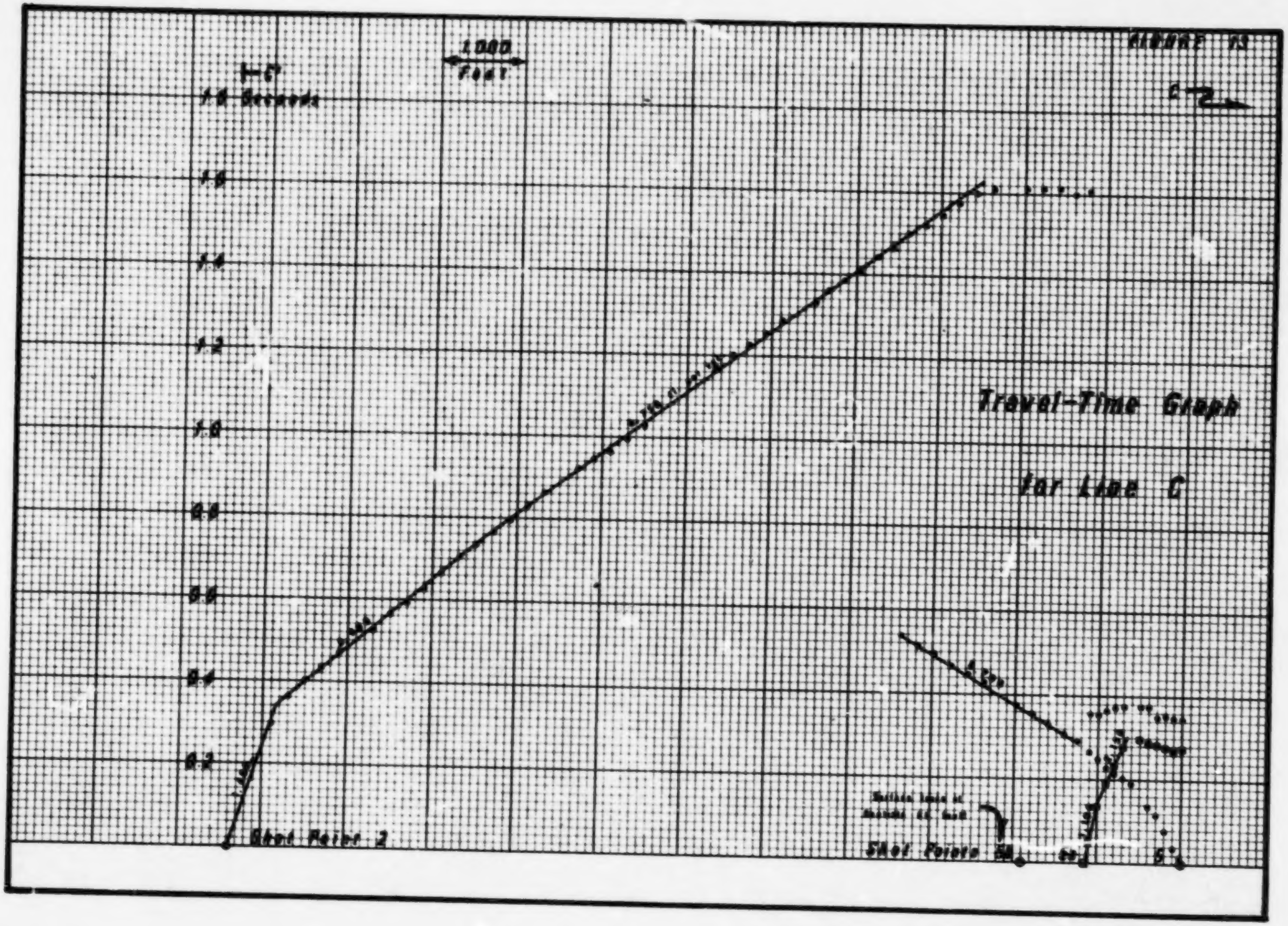


FIGURE 13
Travel-Time Graph
for Line C
1000 Feet
1.8 Seconds
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Shot Point 2
Shot Points
C

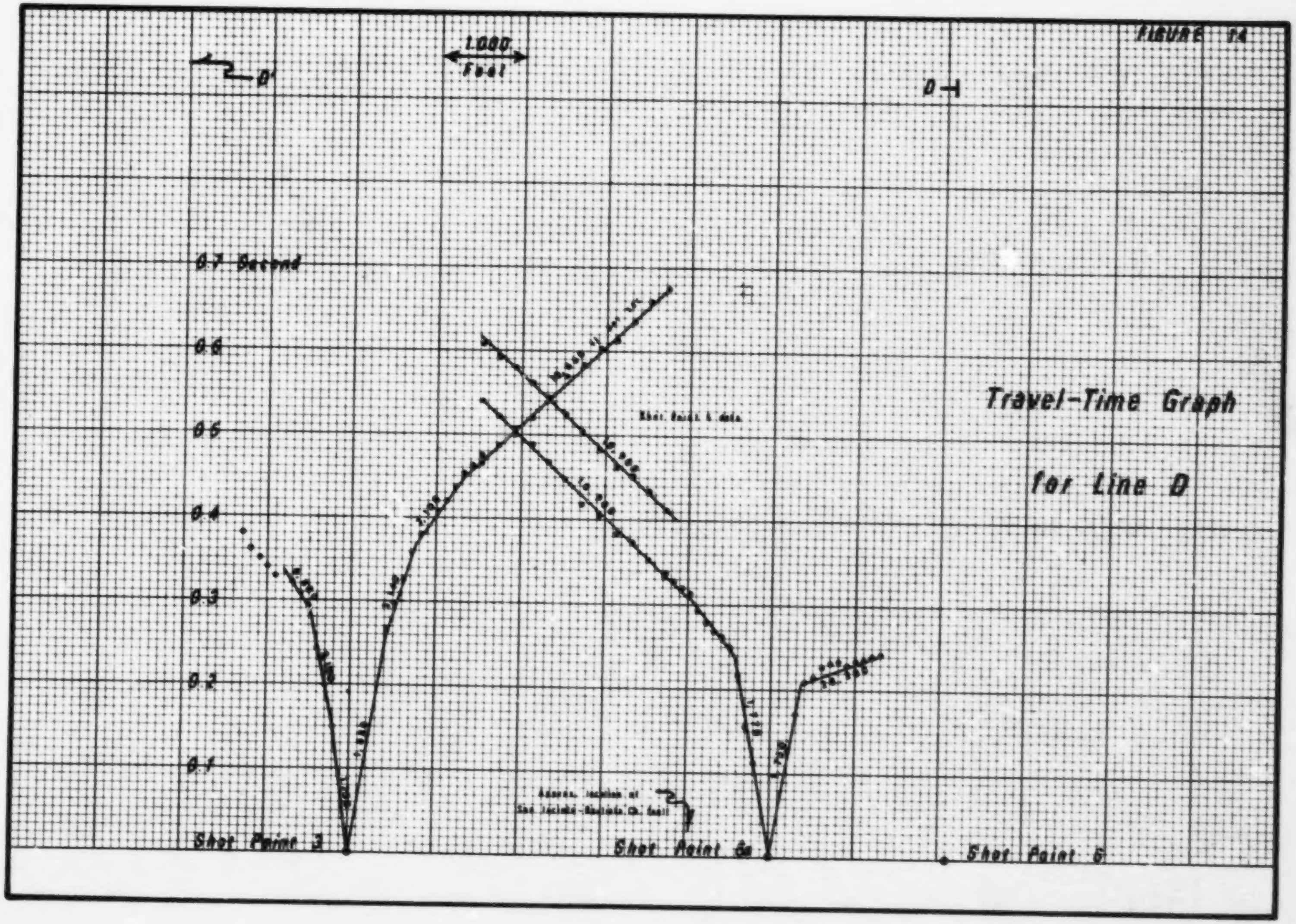


FIGURE 14

Travel-Time Graph for Line D

model with velocities of 2,200, 7,750, and 9,600 feet per second and critical distances of 250 and 3,600 feet.

The seismic data of Line B do not yield clear and precise information on the depth to bedrock. It is likely that a bedrock refraction from Shot Point 2 becomes a first arrival at about 14,000 feet from Shot Point 2. Figure 12 is the seismic recording on which the bedrock refraction appears to become the first arrival. The depth to this refractor is approximately 4,700 feet beneath the middle of Line B. This depth is based on a five layer model with velocities of 1,600, 6,500, 7,350, 10,700 and 15,700 feet per second and critical distances of 500, 2,400, 10,700 and 14,400 feet. This refraction may be a side refraction from the bedrock face of the San Jacinto - Bautista Creek fault. The bedrock depth beneath the middle of Line B is a minimum of 4,700 feet.

Line C

Lines C and D are at right angles to the predominant trend of faulting in the valley.

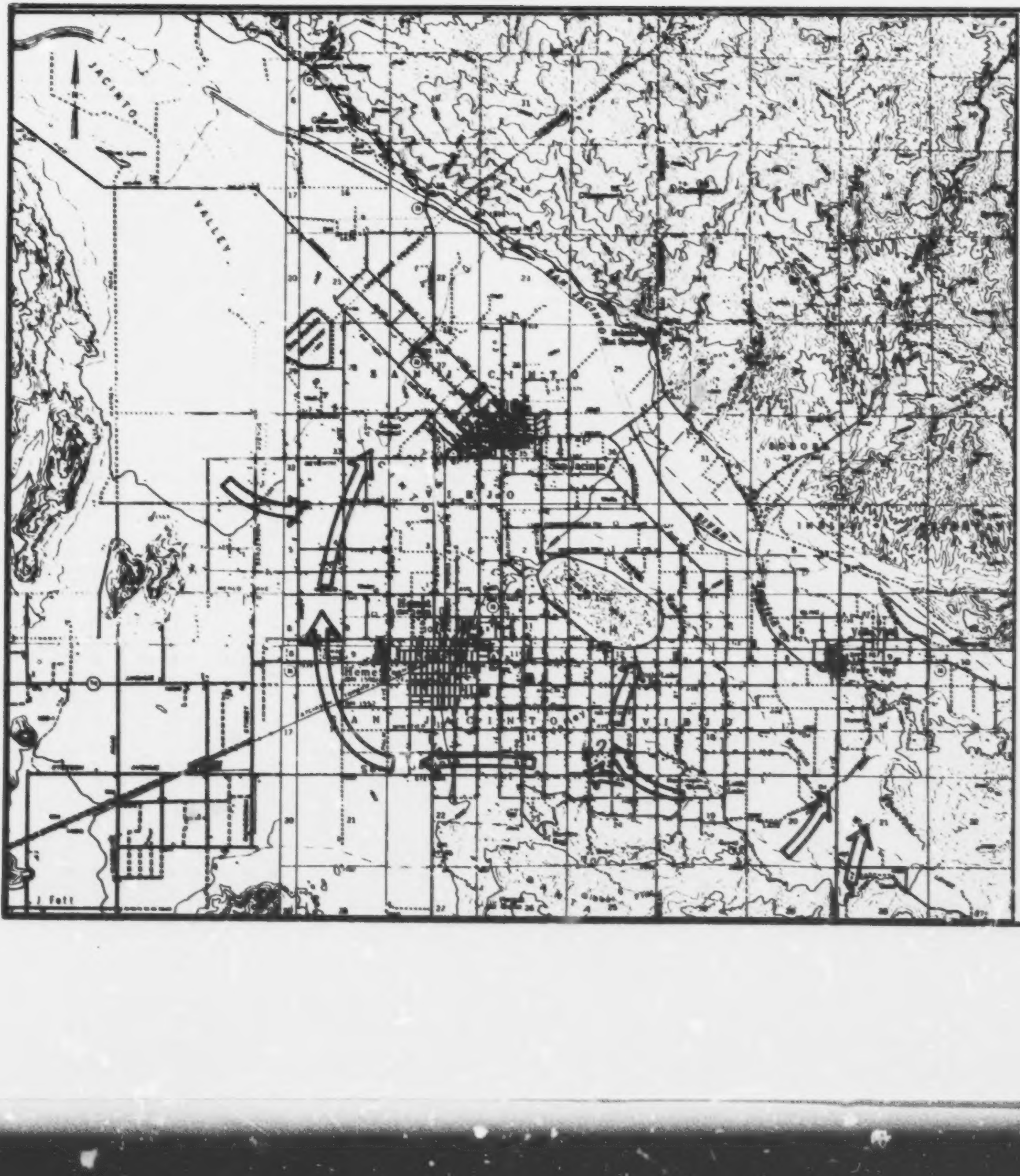
Line C is located between Shot Point 2 and Shot Point 5. Shot Point 5 is about two and a quarter miles southwest of Shot Point 2. Observations along the southwest portion of Line C were supplemented by two small shots, Shot Points 5a and 5b. The locations of these shot points and Line C are plotted on figure 7. Distance and travel-time data are tabulated in the Appendix and plotted on figure 13.

Line C Interpretation

Near the northeast end of Line C, the seismic data indicate a water table at a depth of approximately 210 feet. This depth to the water table is consistent with Line A and B data and an observation of 199 feet, made a month prior to the seismic field work, in a test hole about 600 feet west-southwest of Shot Point 2.

A refractor of higher seismic velocity is indicated at a depth of approximately 580 feet beneath Line C, a quarter of a mile southwest of Shot Point 2. The above-mentioned test hole encountered boulders from a depth of 528 feet to approximately 580 feet. Below this depth, the hole penetrated fine grained clastics and bottomed in these fine grained clastics at a depth of 800 feet. It seems likely that these fine grained sediments are part of the Bautista Formation or younger Pleistocene sediments and a conglomerate was deposited on their erosional surface.

FIGURE 15


JACINTO
VALLEY
J. Fett

Drainage Patterns
on the
Buried Bedrock Surface

ONE MILE

Line D

Line D extends along the Lake Hemet Municipal Water District's flume from Bautista flood control channel, at Shot Point 3, to Shot Point 6, which is located on bedrock about a mile southwest of Shot Point 3. Observations along most of Line D were supplemented by shots in the small reservoir near the center of Section 20, (Shot Point 6a). The locations of Line D and these shot points are plotted on figure 7. The distance and travel-time data are tabulated in the Appendix and plotted on figure 14.

Line D Interpretation

A 1,300 foot spread was recorded from Shot Point 3 to the northeast. It indicated a water table at a little over 200 feet and a higher velocity refractor, probably the Bautista Formation, shoaling to the northeast. The water table depth is based on a three layer model with velocities of 1,250, 2,100, and 6,000 feet per second and critical distances of 200 and 500 feet.

To the southwest, seismic data from Shot Point 3 indicate refractors at depth of 115, 360, and 590 feet. Nearby agricultural water wells cause irregularities in the water table beneath Line D, which in turn make the interpretation of the shallower refractors subject to substantial error. The 10,660 feet per second refractor at a depth of 590 feet is undoubtedly the surface of the Bautista Formation. Assuming a zero dip bedrock of 16,000 feet per second seismic velocity, its minimum depth would be about 1,350 feet. These depths are based on a five layer model with velocities of 1,680, 3,140, 7,100, 10,660, and 16,000 feet per second and critical distances of 420, 870, 1,320, and 3,700 feet.

A few hundred feet southwest of Shot Point 6a, the seismic data from Shot Point 6a indicate bedrock to be at a depth of about 150 feet and shoaling to the southwest with an apparent dip of about 10 degrees. This depth and dip are based on a two layer model with a critical distance of 350 feet, a surface layer velocity of 1,750 feet per second and apparent and assumed true bedrock velocities of 28,200 and 16,000 feet per second, respectively.

To the northeast of Shot Point 6a, the seismic data indicate the water table at a depth of approximately 170 feet and a 10,900 feet per second refractor at a depth of about 350 feet. It is likely that the 10,900 feet per second refractor is the surface of the Bautista Formation. Since the bedrock surface is two to three hundred feet beneath Shot

Point 6a, the seismic waves from Shot Point 6a passed through several hundred feet of bedrock until reaching the San Jacinto-Bautista Creek fault, then refracted from the surface of the Bautista Formation. Correcting for the bedrock portion of the refracted wave's path, the surface of the Bautista Formation is probably at a depth of about 500 to 600 feet on the northeast side of the fault. The information from Shot Point 6 tends to confirm this interpretation.

FINDINGS AND THEIR IMPLICATIONS

The gravity survey has determined, in a qualitative manner, the bedrock topography to the southwest of Casa Loma fault. The Bouguer anomaly with the regional removed, figure 6, shows good correlation between the magnitude of the local Bouguer gravity anomaly and bedrock depths obtained from well log information, figure 3. Based on well log information, seismic information, and mostly gravity information, the drainage patterns on the buried bedrock surface have been plotted on figure 15.

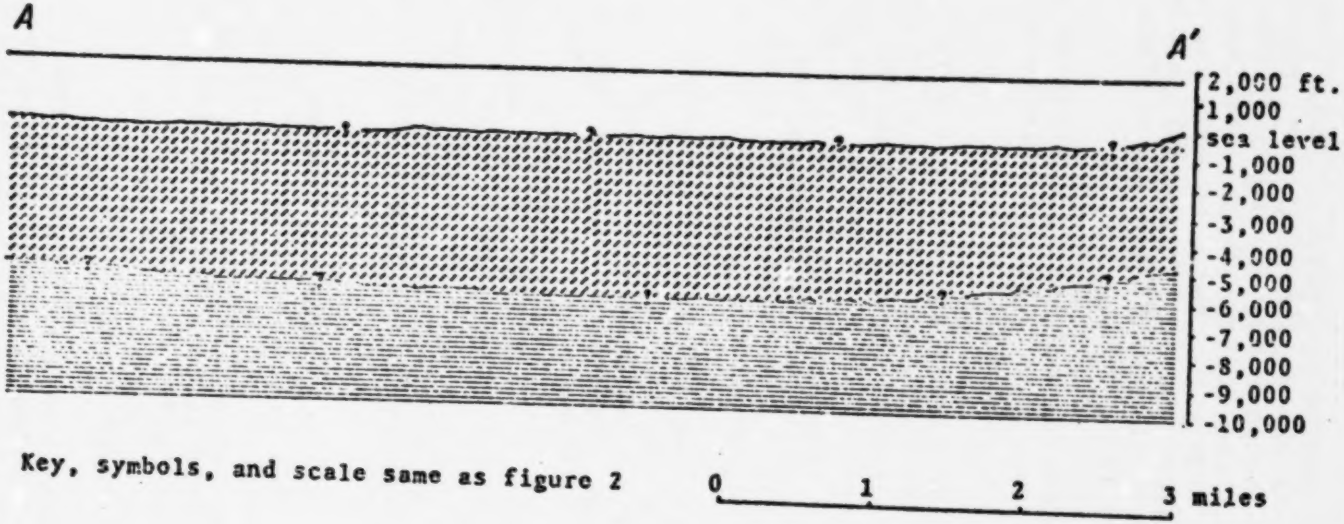
With the detailed processing and interpretation of this and Dr. Eaton's gravity data, it will be possible to plot quantitatively the bedrock elevation.

Knowledge of bedrock configuration beneath the valley fill on the Hemet side of the Casa Loma fault is of prime importance for an understanding of ground water in the area. Wells with optimum specific capacity may be expected to occur where drilled to bedrock along the buried drainage courses on the bedrock surface. In these locations the sediments just above bedrock should be coarser grained than those just above the higher slopes or ridges of the bedrock.

The City of Hemet well near Stetson Avenue and Gilbert Street is an example of this principle. It is located near a trough in the gravity anomaly, and is quite probably located over the channel in the bedrock surface that drained from the east, passing beneath this well site, then turned northward. The well passes through coarser grained sediments, predominently subrounded fine gravel and coarse sand, in the one hundred and fifty feet immediately above bedrock. The specific capacity of the well is excellent and should remain good even if the water table is lowered, since the major zone of production is in the lowest portion of the well.

Though there are few bedrock outcrops between the Casa Loma fault and the hills on the south of the San Jacinto Valley, prolonged overdraft of the valley's ground water has lowered the water table sufficiently for many buried bedrock hills and ridges to form "islands" and "peninsulas" rising above the water table, but not above the surface of the sediments. The area southeast of Florida Avenue and San Jacinto Street is such a region.

As a result of the many barriers formed by the irregular surface of the buried bedrock, a well of good specific capacity may lower the water table in its vicinity an abnormal amount if the well is located in an alcove and cut off


A
A′
2,000 ft.
1,000
sea level
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
0
1
2
3 miles

Key, symbols, and scale same as figure 2

FIGURE 16. GEOLOGIC SECTION A

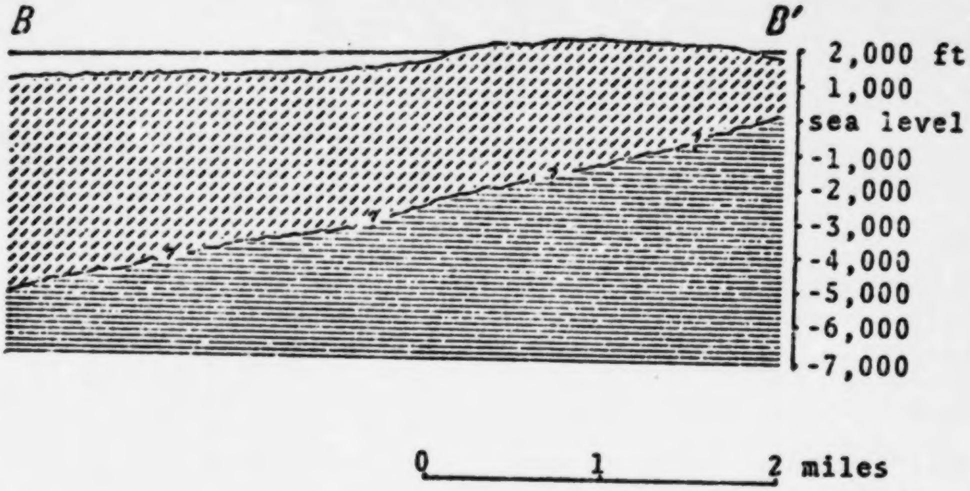
on several sides by such barriers. If the water table continues to decline, these barriers become increasingly important in the prediction of the long term potential of a well site. The buried drainage courses on the bedrock surface become increasingly important in the location of wells of sufficient yield to be economical sources of water supply.

Based on the interpretation of the seismic data, and available subsurface information, five geologic cross sections of the valley have been constructed. The locations of the geologic sections are plotted on figure 7. The sections constitute figures 16 through 19. Figure 20 is a block diagram of the San Jacinto-Valley area.

Geologic Sections A, figure 16, is approximately along the alignment of seismic Line A. The depth to bedrock beneath San Jacinto is about 8,000 or more feet. The San Jacinto fault zone has dropped a wedge of bedrock, between the Claremont fault on the northeast side of the valley, and the Casa Loma fault that passes through the center of the valley. The writer suggests the name San Jacinto graben for this rift. The graben is continuing to increase in depth, as is indicated by the recentness of faulting on both the Casa Loma and Claremont faults. The dip of these faults is unknown. Near the surface, Proctor (1962) and Buwalda (Bean, 1955) observed a northeasterly dip of the Casa Loma fault in the unconsolidated Recent sediments. Most of the faults encountered near the Claremont fault in the San Jacinto tunnel of the Colorado River aqueduct dip steeply toward the northeast. If the 8,650-8,700 feet per second refractor of Line A represents the erosional surface of the Bautista Formation, this surface is about 2,000 feet deep through most of Section A.

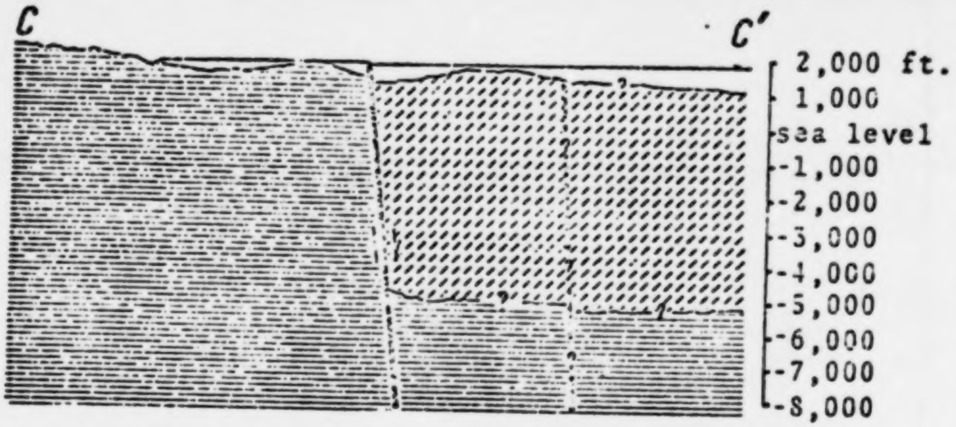
Geologic Section B, figure 17, is approximately along the alignment of seismic Line B. The depth to bedrock at the center of this section is at least 4,700 feet and may be deeper if the refraction from bedrock is a side refraction from the bedrock face of the San Jacinto - Bautista Creek fault. The erosional surface of the Bautista Formation is probably at a depth of about 500 feet near the northwest end of Section B and crops out along the southeastern portion of this geologic section.

Geologic Section C, figure 18, is along the seismic Line C alignment and also extended to the southwest. At the center of this section is the Bautista Creek fault. There are a few feet of Recent vertical offset at the surface. On the southwest side of the fault, bedrock is at a depth of about 800 feet. On the northeast, bedrock depth is

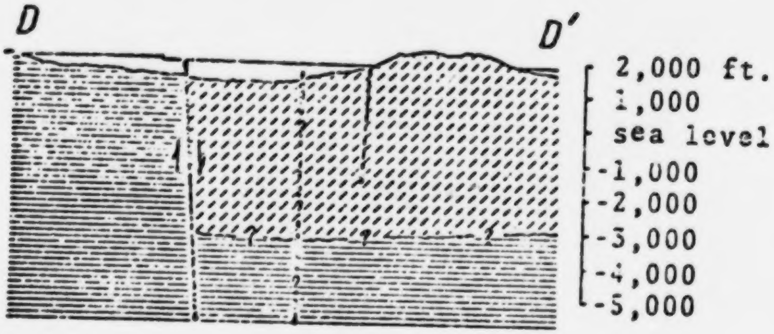

B
B'
2,000 ft.
1,000
sea level
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
0
1
2 miles

Key, symbols, and scale same as figure 2

FIGURE 17. GEOLOGIC SECTION B


C
C'
2,000 ft.
1,000
sea level
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
?

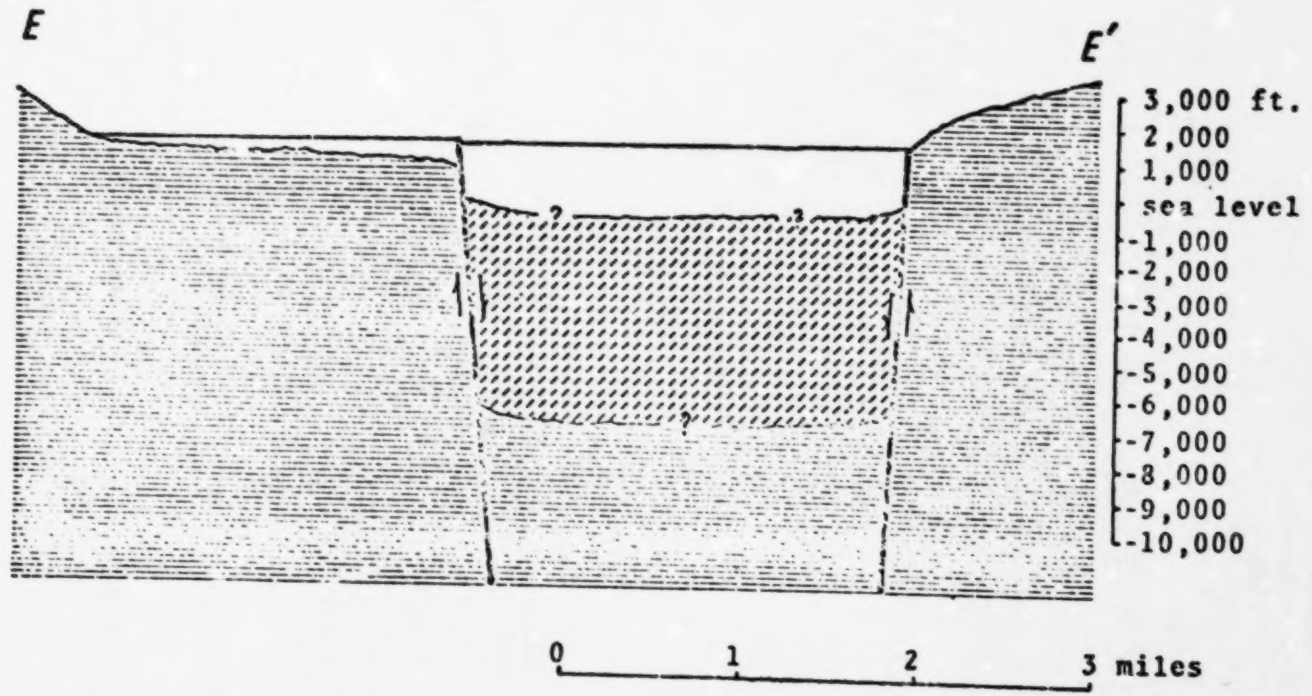
GEOLOGIC SECTION C 0 1 mile


D
D'
2,000 ft.
1,000
sea level
-1,000
-2,000
-3,000
-4,000
-5,000
?

GEOLOGIC SECTION D 0 1 mile

Key, symbols, and scale same as figure 2

FIGURE 18. GEOLOGIC SECTIONS C&D


E
E′
3,000 ft.
2,000
1,000
sea level
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
-7,000
-8,000
-9,000
-10,000
?
?
?
0
1
2
3 miles

Key, symbols, and scale same as figure 2

FIGURE 19. GEOLOGIC SECTION E

probably in excess of 3,000 feet, and may be much deeper.

Geologic Section D, figure 18, is along the alignment of seismic Line D, and extended to the northeast. From the hills south of the valley, the bedrock surface passes beneath the alluvium. At the San Jacinto - Bautista Creek fault, beneath the D alignment, the bedrock surface is at a depth of 400 to 600 feet on the southwest. On the northeast side of this fault, bedrock is in excess of 1,350 feet and probably deeper than 4,500 feet. The surface of the Bautista Formation reaches a maximum depth of about 550 feet between this fault and the hills to the northeast, which are composed of Bautista Formation and capped, in places, with younger terrace forming sediments.

Geologic Section E, figure 19, is based partly on seismic work of Dr. Eaton and the writer. Southwest of the Casa Loma fault, a seismic line was performed along a portion of the alignment of Section E. This seismic work found the bedrock surface at a depth of about 380 feet midway between the Lakeview mountains and the Casa Loma fault. This bedrock depth increased to a depth of 500 to 600 feet near the Casa Loma fault (Eaton, personal communication). Bedrock depth northeast of the fault is probably 7,000 to 8,000 feet, based on seismic Line A information.

The San Jacinto fault enters the valley at the mouth of Bautista Canyon, continues northwest under the name "Bautista Creek fault", and further northwest under the name "Casa Loma fault". Fault movement appears to have an increasingly greater dip-slip component toward the northwest. Perhaps some future confusion might be avoided if this fault would be called Casa Loma fault from the mouth of Bautista Canyon to the northwest, and the San Jacinto fault to the southeast of the canyon mouth.

Sharp (1967) has mentioned that the San Jacinto fault zone has, in addition to many miles of right-lateral offset, considerable vertical offset, having dropped the area northeast with respect to that on the southwest. The same sense of vertical movement is true of the Casa Loma fault.

Though the Casa Loma fault is less obtrusive in surface appearance that the Claremont fault, it is a major active fault. Because of its more subtle appearance, it is perhaps the more dangerous fault, for houses and structures, such as the San Jacinto reservoir, have been built along this fault. Its scarp has provided enough topographic relief to make attractive building sites.

Park Hill and Casa Loma are probably fault slivers.

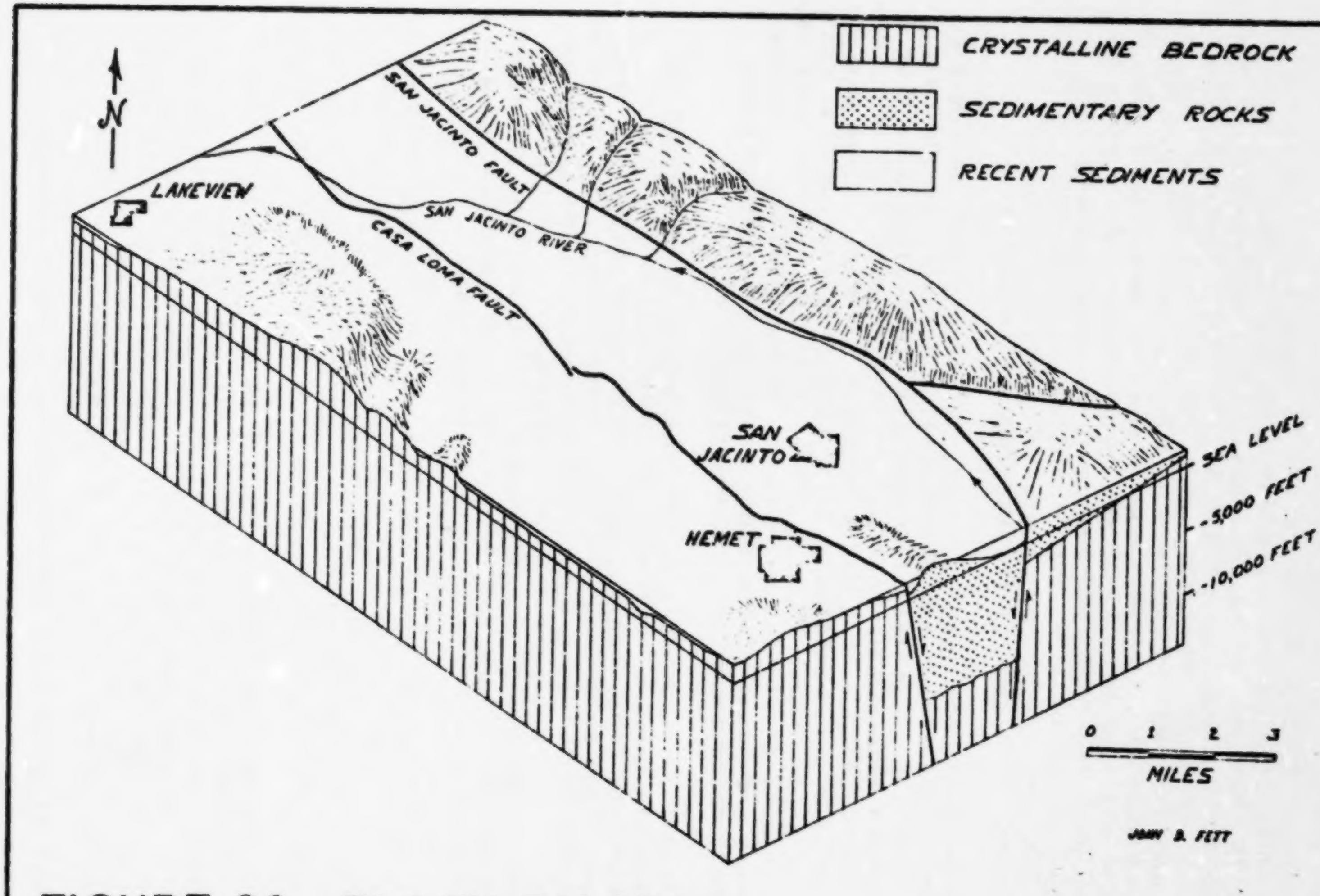

CRYSTALLINE BEDROCK
SEDIMENTARY ROCKS
RECENT SEDIMENTS
N
LAKEVIEW
SAN JACINTO FAULT
SAN JACINTO RIVER
CASA LOMA FAULT
SAN JACINTO
HEMET
SEA LEVEL
-5,000 FEET
-10,000 FEET
0 1 2 3
MILES
JOHN B. FETT

FIGURE 20. BLOCK DIAGRAM

Geomorphic evidence suggests Park Hill to be bounded on its northeast by a fault, named the Park Hill fault. Though the existence of the Park Hill fault is most likely, the writer has not seen any definite evidence of its existence or non-existence.

Because of the activeness and size of the Casa Loma and Claremont faults, serious consideration and careful design should be used in structures and improvements near these faults. Both surface disruption and severe seismic vibrations are to be expected.

Future deep seismic investigation in the area can be performed with substantial savings in time and explosives if a greater number of recording channels are used and if the recording locations at greater distance from the shots or in areas of high background noise utilize multiple detectors for each channel. Recording during the early morning hours would also help avoid excessive background noise and reduce the minimum shot size required for a clear signal.

The gravity anomaly associated with the San Jacinto graben will be calculated and compared to the observed anomaly. Near the center of the graben the water table is at a depth of approximately 150 feet. The 1,920-2,200 foot refractor is assumed to be the surface of the Bautista Formation and an 8,000 foot depth to bedrock is used. In another part of the San Jacinto ground water basin, Eaton (personal communication) determined densities of 1.9, 2.3, and 2.7 for shallow unsaturated alluvium, shallow saturated alluvium, and granodiorite bedrock, respectively. From a depth of 1,000 feet to the surface of the Bautista Formation, a density of 2.4 seems reasonable because of the greater depth of burial (McCulloh, 1967). From the surface of the Bautista Formation to a depth of 5,000 feet, a density of 2.5 is assumed and from 5,000 feet to the bedrock surface, a density of 2.55 is assumed (McCulloh, 1967). Using these values, a 23.3 milligal anomaly is calculated. This is in close agreement with the observed anomaly of approximately 23 milligals.

ACKNOWLEDGEMENT

Dr. Gordon P. Eaton, of the University of California at Riverside, suggested the gravity survey in the San Jacinto Valley because of the writer's familiarity with its geology. Dr. Eaton later arranged with Eastern Municipal Water District to have the District pay for explosives for the seismic work, and supply the men and equipment for placing the charges. (Dr. Eaton also arranged to have the District do leveling so he and his students could extend the gravity work of the writer.)

Drs. Shawn Biehler and Stewart Smith, of the California Institute of Technology, together with some of their students, recorded about half the data from Shot Point 1 and supervised shotpoint operations at Shot Point 1.

Dr. Eaton and the writer, with the aid of UCR graduate students, recorded the data of Line A from Shot Point 2.

Eastern Municipal Water District, and in particular James Lenihan of the District, made the seismic work possible. Without their financial support for explosives and their men and equipment for planting the explosives, the project would not have been possible. They also supplied radio equipment for transmitting shot time information and coordinating spread and shot point work.

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APPENDIX: GRAVITY DATA

Column 1: Station number

Column 2: Latitude in degrees, minutes, and hundredths of a minute (example: 334403 is 33° 44.03')

Column 3: Longitude

Column 4: Elevation in tenths of a foot if followed by a T and in feet if followed by a U (example: 17360T is 1736.0 feet above sea level; 1717U is 1717 feet above sea level)

Column 5: Observed gravity minus 978,000.00 milligals (example: 143737 is 979,437.37 milligals)

Column 6: Theoretical gravity at sea level minus 978,000.00 milligals (example: 163921 is 979,639.21 milligals)

Column 7: Free air anomaly in hundredths of a milligal (example: -3855 is -38.55 milligals)

Column 8: Bouguer anomaly in hundredths of a milligal plus 1,000.00 milligals (example: 90318 is 1,000.00 - 903.18 = -96.82 milligals) 2.67 rock density used for correction

Column 9: Bouguer anomaly, as above, but with 2.00 rock density used for correction.

	1	2	3	4	5	6	7	8	9
JF	101	334403	1165564	17360T	143737	163921	-3855	90318	91780
JF	102	334410	1165564	17275T	143609	163930	-4072	90133	91586
JF	103	334422	1165564	17218T	143414	163947	-4338	89886	91335
JF	104	334433	1165564	1717U	143247	163962	-4566	89674	91120
JF	105	334444	1165564	1711U	143106	163978	-4778	89452	90922
JF	106	334453	1165564	1708U	142950	163990	-4975	89205	90733
JF	107	334465	1165564	17041T	142810	164007	-5168	89117	90551
JF	108	334476	1165564	1701U	142678	164022	-5344	88951	90383
JF	109	334487	1165564	1699U	142570	164037	-5486	88815	90245
JF	110	334497	1165564	1696U	142464	164051	-5635	88677	90105
JF	111	334508	1165564	16934T	142559	164066	-5580	88741	90166
JF	112	334508	1165537	16980T	142268	164066	-5827	88478	89907
JF	113	334487	1165537	17070T	142330	164037	-5651	88623	90060
JF	114	334476	1165537	17110T	142397	164022	-5532	88728	90169
JF	115	334465	1165537	17150T	142513	164007	-5362	88885	90328
JF	116	334455	1165537	17210T	142637	163993	-5168	89056	90506
JF	117	334444	1165537	1724U	142808	163978	-4954	89261	90712
JF	118	334434	1165537	1727U	142973	163964	-4746	89458	90913
JF	119	334422	1165537	17275T	143163	163947	-4535	89670	91124
JF	120	334412	1165537	1738U	143298	163933	-4287	89881	91345
JF	121	334400	1165537	17425T	143520	163916	-4006	90146	91613
JF	122	334381	1165512	1765U	143475	163890	-3814	90272	91756
JF	123	334390	1165512	1760U	143305	163903	-4043	90058	91530
JF	124	334400	1165512	1757U	143152	163916	-4238	89871	91340
JF	125	334409	1165512	17521T	143011	163929	-4438	89690	91164
JF	126	334422	1165512	17463T	142854	163947	-4667	89470	90948
JF	127	334444	1165512	1735U	142531	163978	-5127	89057	90516
JF	128	334465	1165512	17208T	142280	164007	-5541	88694	90141
JF	129	334487	1165512	17138T	142088	164037	-5829	88430	89871
JF	130	334530	1165512	16935T	141867	164097	-6300	88034	89456
JF	131	334552	1165512	1679U	141859	164127	-6476	87910	89310
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JF	133	334575	1165485	1671U	141830	164159	-6612	87825	89221
JF	134	334552	1165485	16885T	141754	164127	-6492	87673	89267
JF	135	334531	1165484	17010T	141733	164098	-6366	87954	89380
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JF	139	334487	1165427	1745U	141557	164037	-6067	88117	89576
JF	140	334487	1165395	1757U	141485	164037	-6026	88115	89555
JF	141	334510	1165427	1727U	141579	164069	-6246	88001	89445
JF	143	334466	1165484	1735U	141995	164008	-5694	88502	89959
JF	144	334444	1165484	1747U	142259	163978	-5266	88866	90233
JF	145	334422	1165484	1762U	142544	163947	-4830	89272	90762
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JF	150	334422	1165459	17605T	142243	163947	-4957	89080	90576

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JF    151 334422  1165381   1812U  141440  163947  -5463  88510  90022
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JF    156 334422  1165616   1695U  143959  163947  -4045  90256  91686
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JF    158 334422  116566816672T    144434  163947  -3831  90553  91962
JF    159 334421  116569416526T    144650  163946  -3751  90683  92080
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JF    162 334421  116577216185T    145128  163946  -3593  90940  92312
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JF    164 334420  116582515943T    145403  163944  -3545  91067  92419
JF    165 334420  1165851   1582U  145575  163944  -3489  91157  92500
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JF 201	334486	1165747	1625U	144866	164036	-3886	90630	92007
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JF 203	334487	1165694	1646U	144256	164037	-4298	90157	91548
JF 204	334487	1165668	1657U	143850	164037	-4601	89816	91217
JF 205	334487	1165642	1664U	143584	164037	-4801	89508	91003
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JF 208	334399	1165642	16836T	144335	163915	-3744	90591	92013
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JF 210	334399	1165694	1652U	144728	163915	-3649	90789	92185
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JF 212	334399	1165747	1626U	145060	163915	-3561	90956	92332
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JF 219	334377	1165694	1656U	144794	163885	-3495	90926	92326
JF 220	334377	1165720	16464T	144969	163885	-3430	91020	92413
JF 221	334377	1165799	1601U	145458	163885	-3368	91226	92583
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JF 223	334377	1165851	1578U	145688	163885	-3354	91308	92648
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JF 225	334398	1165825	1594U	145439	163914	-3482	91133	92484
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JF 233	334376	1165929	1550U	146110	163883	-3194	91556	92874
JF 234	334356	1165616	16995T	144418	163855	-3452	90847	92278
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JF 239	334507	1165903	1563U	145517	164065	-3847	90851	92189
JF 240	334507	1165876	15718T	145387	164065	-3893	90787	92122
JF 241	334507	1165851	1579U	145240	164065	-3973	90683	92024
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JF 243	334507	1165798	1594U	144917	164065	-4155	90458	91810
JF 244	334507	1165772	16083T	144809	164065	-4129	90430	91802
JF 245	334507	1165746	1620U	144652	164065	-4145	90388	91760
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JF	253	334529	1165721	1620U	144118	164095	-4740	89795	91166
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JF	256	334528	1165799	15916T	144800	164094	-4323	90300	91649
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JF	258	334528	1165851	1574U	145182	164094	-4107	90568	91904
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JF	261	334550	1165878	15646T	145337	164125	-4071	90636	91964
JF	262	334550	1165851	1573U	145116	164125	-4213	90465	91801
JF	263	334550	1165825	1580U	144985	164125	-4378	90286	91625
JF	264	334551	1165773	15969T	144640	164126	-4465	90144	91497
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JF	266	334551	1165747	1605U	144149	164126	-4880	89707	91066
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JF	268	334400	1165454	1776U	142816	163916	-4395	89658	91150
JF	269	334400	1165459	1792U	142505	163916	-4556	89440	90947
JF	270	334530	1165559	1682U	142367	164097	-5909	88456	89870
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JF	272	334552	1165537	16755T	141987	164127	-6380	88008	89416
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JF	293	334636	[illegible]	15279T	146086	164244	-3787	91040	92338
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JF	296	334572	1165983	1534U	146124	164155	-3603	91200	92504
JF	297	334549	[illegible]	15373T	146098	164123	-3565	91224	92532

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JF	301	334572	1165955	1537U	145894	164155	-3804	90994	92300
JF	302	334572	1165930	15445T	145662	164155	-3966	90807	92118
JF	303	334572	1165903	1552U	145490	164155	-4067	90683	92001
JF	304	334572	1165876	15590T	145324	164155	-4167	90563	91886
JF	305	334550	1165903	1556U	145531	164125	-3957	90776	92097
JF	306	334550	1165955	1545U	145870	164125	-3772	91046	92359
JF	307	334594	1165957	1536U	145860	164186	-3876	90923	92228
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JF	309	334594	1165903	1548U	145393	164186	-4233	90531	91845
JF	310	334594	1165876	15562T	145233	164186	-4315	90425	91744
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JF	312	334487	1165590	1690U	142856	164037	-5255	89061	90487
JF	313	334465	1165590	1693U	143161	164007	-4921	89385	90814
JF	314	334444	1165590	1705U	143396	163978	-4544	89720	91159
JF	315	334422	1165590	1710U	143684	163947	-4179	90070	91513
JF	316	334399	1165590	1710U	144009	163915	-3822	90429	91871
JF	317	334377	1165590	1704U	144190	163885	-3667	90611	92047
JF	318	334356	1165589	1714U	144213	163855	-3520	90729	92172
JF	319	334338	1165589	1725U	144246	163830	-3359	90856	92308
JF	320	334528	1165930	1554U	145668	164094	-3809	90928	92249
JF	321	334614	1165930	1539U	145555	164213	-4183	90608	91915
JF	322	334659	1165931	1533U	145261	164276	-4496	90321	91621
JF	323	334680	1165983	15238T	145974	164305	-3998	90847	92141
JF	324	334680	1165957	1527U	145597	164305	-4345	90497	91791
JF	325	334681	1165932	15308T	145102	164306	-4806	90024	91321
JF	326	334681	1165905	1521U	144702	164306	-5297	89571	90859
JF	327	334681	1165866	15240T	144012	164306	-5959	88906	90194
JF	328	334682	1165826	15312T	143497	164308	-6408	88445	89737
JF	329	334682	1165800	1541U	143203	164308	-6610	88210	89510
JF	330	334682	1165774	15485T	142963	164308	-6780	88021	89326
JF	331	334682	1165748	1557U	142794	164308	-6868	87913	89223
JF	332	334652	1165702	15755T	142643	164266	-6804	87919	89243
JF	333	334652	1165661	1594U	142407	164266	-6866	87793	89134
JF	334	334552	1165607	16100T	142236	164127	-6748	87852	89207
JF	335	334116	1165725	1679U	145395	163523	-2335	92029	93444
JF	336	334323	1165595	17174T	144446	163810	-3210	91041	92483
JF	337	334321	1165563	1724U	144280	163807	-3311	90937	92380
JF	338	334336	1165459	1852U	143037	163828	-3371	90432	91987
JF	339	334357	1165505	1601U	143502	163857	-3414	90562	92074
JF	340	334529	117 213	15072T	147890	164095	-2029	92861	94143
JF	341	335026	117 397	1491U	147839	164786	-2922	92055	93315
JF	342	334702	1165932	1518U	144864	164336	-5193	89681	90967
JF	343	334724	1165932	15141T	144569	164366	-5556	89332	90615
JF	344	334745	1165932	15053T	144331	164395	-5905	89020	90293
JF	345	334768	1165932	15001T	144097	164427	-6221	88725	90003
JF	346	334824	1165932	1495U	143693	164505	-6750	88225	89486

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	1	2	3	4	5	6	7	8	9
JF	347	334548	1165926	14-55T	143569	164538	-6950	88049	89302
JF	348	334662	1165906	14550T	143435	164559	-7119	87906	89155
JF	349	334697	1165906	1486U	143474	164606	-7155	87904	89144
JF	350	335033	1165920	1496U	144613	164754	-6169	88923	90155
JF	351	334525	117 697	1722U	147962	164090	70	94236	95700
JF	352	334635	117 535	2219U	147455	164243	2084	94572	96457
JF	353	334402	117 528	1760U	147910	164474	-10	94031	95527
JF	354	334438	1165720	1685T	144834	163966	-3721	90750	92137
JF	355	334265	1165920	1642U	144940	163906	-3511	90953	92342
JF	356	334376	1165811	1668U	144836	163463	-3299	91307	92728
JF	357	334376	1165922	1659U	144112	163663	-3132	91558	92876
JF	358	334285	1165922	1542U	146630	163767	-2285	92327	93654
JF	359	334322	1165922	1540U	146647	163422	-2614	91052	92265
JF	360	[illegible]	1165529	1544U	146616	163914	-3287	91466	92782
JF	361	[illegible]	1165-29	1550U	146649	163943	-3324	91426	92743
JF	362	[illegible]	117 551	1254T	146730	163883	-2732	92092	93391
JF	363	33440-	117	1520U	146730	163929	-2902	91942	93236
JF	364	[illegible]	117	15220T	146646	164004	-3043	91705	93091
JF	365	[illegible]	117	152-U	146684	164033	-3114	91717	93014
JF	366	[illegible]	117	1520U	146664	164064	-3173	91658	92955
JF	367	[illegible]	117 5	1532U	146329	164064	-3325	91481	92785
JF	368	[illegible]	1165874	1540U	146826	164064	-3637	91115	92432
JF	369	[illegible]	1165828	1377U	144718	164166	-4604	90074	91410
JF	370	[illegible]	[illegible]	16351	144603	164183	-4884	90841	91165
JF	371	33462	1165-26	15412T	144264	164222	-5463	89342	90646
JF	372	334637	1165801	15415T	143668	164265	-6008	88711	90014
JF	373	[illegible]	1165778	[illegible]	143747	164201	-5785	88960	90278
JF	374	[illegible]	1165374	166	142295	164120	-6127	88284	89686
JF	375	[illegible]	1165596	165	142380	164140	-6201	88247	89642
JF	376	[illegible]	11656	1627T	142665	164165	-6182	88166	89727
JF	377	[illegible]	1161672	1610U	142783	164183	-6210	88163	89725
JF	378	[illegible]	1165646	1618U	142662	164183	-6302	88160	89624
JF	379	[illegible]	1165625	1627U	142443	164162	-6436	88111	89480
JF	380	334616	[illegible]	16 U	142173	164214	-6750	87707	89163
JF	381	334615	1165635	1611T	142204	164216	-6664	87930	89294
JF	382	334633	1165701	1584U	142214	164240	-6635	88061	89392
JF	383	334634	[illegible]	[illegible]	142456	164241	-6780	87874	89216
JF	384	334634	1165635	[illegible]	142242	164241	-6821	87724	89168
JF	385	334622	[illegible]	1594U	142279	164305	-6942	87722	89061
JF	386	[illegible]	[illegible]	1594U	142335	164337	-7009	87696	89025
JF	387	334724	1165583	1596U	142566	164366	-6758	87930	89262
JF	388	334744	1165557	1632U	142750	164304	-6293	88366	89706
JF	390	334761	1165664	-0	143165	164556	-21401	88825	89266
JF	391	[illegible]	[illegible]	-0	143791	164606	-20816	91246	89729
JF	392	3348	1165824	13035T	143401	164604	-7063	88050	89276
JF	393	33466	[illegible]	12-T	143149	164461	-7180	87934	89083
JF	394	334816	[illegible]	1519U	143011	164494	-7195	87746	89015
JF	395	334787	[illegible]	1721U	143137	164454	-7010	87890	89170
JF	396	334772	1165868	1520U	143310	164433	-6817	88078	89350

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     1      2       3      4       5       6       7      8      9
JF 397 334724 1165826 1532U  143196  164366  -6760  88095  89386
JF 398 334583 116577315665T  144145  164170  -5291  89429  90754
JF 399 334575 1165722 1631U  143343  164159  -5475  89027  90407
JF 400 334574 1165705 1614U  143290  164158  -5687  88881  90244
JF 401 334572 117   35 1521U  146490  164155  -3359  91486  92780
JF 402 334637 117   35 1517U  146602  164245  -3374  91488  92777
JF 403 334682 117   35 1515U  146497  164308  -3561  91311  92598
JF 404 334723 117   36 1510U  146313  164365  -3849  91038  92321
JF 405 334798 117   36 1496U  145410  164469  -4987  89957  91226
JF 406 334762 117   36 1502U  145866  164419  -4425  90493  91768
JF 407 334723 116598415161T  145470  164365  -4634  90238  91525
JF 408 334723 1165957 1513U  145053  164365  -5081  89811  91093
JF 409 334747 116580115365T  142912  164398  -7034  87819  89110
JF 410 334762 1165783 1539U  142789  164419  -7154  87699  88990
JF 411 334725 1165748 1556U  142646  164368  -7086  87709  89015
JF 412 334791 1165749 1543U  142744  164459  -7202  87685  88968
JF 413 334811 1165749 1540U  142815  164487  -7166  87741  89014
JF 414 334811 1165723 1548U  142822  164487  -7105  87816  89091
JF 415 334827 1165703 1543U  143022  164509  -6973  88043  89293
JF 416 334805 1165678 1547U  142905  164479  -7023  87963  89221
JF 417 334757 1165723 1557U  142592  164412  -7175  87644  88944
JF 418 334749 116567015745T  142531  164401  -7060  87724  89033
JF 419 334726 116567015815T  142461  164369  -7033  87704  89025
JF 420 334703 116567015815T  142392  164337  -7069  87655  88979
JF 421 334682 1165669 1587U  142383  164308  -6998  87700  89031
JF 422 334682 116570215745T  142527  164308  -6971  87768  89038
JF 423 334666 1165702 1574U  142459  164286  -7022  87708  89031
JF 425 334667 1165637 1597U  142311  164287  -6954  87718  89055
JF 426 334780 117 21715093T  147554  164444  -2693  92228  93502
JF 424 334305 1165825 1587U  142414  163785  -6443  88203  89546
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SEISMIC DATA - LINE A

Spread	Distance*	Time
UCR-I	74 feet	0.057
	260	0.092
	469	0.133
	678	0.177
	883	0.208
	1094	0.247
	1392	0.284
	1553	0.320
	1763	0.358
	1970	0.394
	2176	0.429
	2384	0.468
UCR-II	9,000	1.522
	9,200	1.556
	9,400	1.589
	9,600	1.623
	9,800	1.652
	10,000	1.674
	10,233	1.710
	10,438	1.731
	10,641	1.764
	10,843	1.794
	11,049	1.820
	11,250	1.841
JDF-I	11,250	1.841
	11,349	1.862
	11,448	1.873
	11,547	1.887
	11,546	1.906
	11,745	1.919
	11,844	1.929
	11,943	1.943
	12,042	1.959
	12,141	1.976
	12,240	1.991
	12,340	2.006

Spread	Distance	Time
CIT-I	13,700	2.184
	13,900	2.212
	14,100	2.238
	14,300	2.266
	14,500	2.293
	14,700	2.313
	14,900	2.342
	15,100	2.372
CIT-II	15,300	2.408
	15,500	2.429
	15,700	2.451
	15,900	2.471
	16,100	2.502
	16,300	2.520
	16,500	2.544
	16,700	2.562
CIT-III	18,100	2.731
	18,300	2.761
	18,500	2.770
	18,700	2.797
	18,900	2.808
	19,100	2.838
	19,300	2.864
	19,500	2.883
JDF-II	18,785	2.793
	18,885	2.809
	18,985	2.823
	19,085	2.836
	19,185	2.853
	19,285	2.861
	19,385	2.871
	19,485	2.871
	19,585	2.885
	19,685	2.903
	19,785	
	19,885	2.925

* Distance from Shot Point 1 at northwest end of line

Line A continued

Spread	Distance	Time	
CIT-IV	19,900	2.947	
	20,100	2.967	
	20,300	3.001	
	20,500	3.035	
	20,700	3.052	
	20,900	3.067	
	21,100	3.089	
CIT-V	28,900	3.789	
	29,100	3.809	
	29,300	3.823	
	29,500	3.842	
	29,700	3.862	
	29,900	3.875	
	30,100	3.897	
	30,300	3.911	
CIT-VI	31,100	4.038	
	31,300	4.044	
	31,500	4.076	
	31,700	4.106	
	31,900	4.139	
	32,100	4.154	
	32,300	4.176	
	32,500	4.188	
JDF-III	34,800	4.348	4.429
	34,900	4.354	4.438
	35,000	4.357	4.441
	35,100	4.360	4.447
	35,200	4.371	4.454
	35,300	4.380	4.456
	35,400	4.379	4.462
	35,500	4.383	4.467
	35,600		
	35,700		
	35,800	4.390	
	35,900		

Line A continued

Spread	Distance*	Time
1	1,300	0.470
	1,490	0.492
	1,680	0.515
	1,870	0.535
	2,060	0.552
	2,250	0.580
	2,450	0.615
	2,620	0.645
	2,810	0.673
	3,000	0.706
	3,200	0.732
	3,400	0.760
2	3,400	0.760
	3,589	0.785
	3,778	0.812
	3,967	0.849
	4,156	0.875
	4,345	0.903
	4,534	0.929
	4,723	0.954
	4,912	0.987
	5,101	1.008
	5,290	1.038
	5,479	1.066
3	5,668	1.094
	5,857	1.116
	6,046	1.144
	6,235	1.179
	6,424	
	6,613	1.235
	6,802	1.267
	6,991	1.294
	7,180	1.329
	7,369	1.364
	7,558	1.388
	7,747	1.420

Spread	Distance	Time
4	7,936	1.451
	8,125	1.478
	8,314	1.509
	8,503	1.530
	8,692	1.557
	8,881	1.588
	9,070	1.624
	9,259	1.655
	9,448	1.679
	9,637	1.715
	9,826	1.734
	10,015	1.756
5	10,204	1.777
	10,393	1.796
	10,582	1.816
	10,761	1.838
	10,950	1.868
	11,139	1.907
	11,328	1.931
	11,517	1.960
	11,706	1.978
	11,895	2.004
	12,084	2.033
	12,273	2.047
6	14,100	2.223
	14,291	2.249
	14,481	2.271
	14,672	2.294
	14,863	2.315
	15,054	
	15,245	2.359
	15,436	2.377
	15,621	2.403
	15,812	2.427
	16,003	2.443
	16,194	2.471

Distance between Shot Points 1 and 2: 39,430 feet

* Distance from Shot Point 2 at southeast end of line

Line A continued

Soread	Distance*	Time	Spread	Distance	Time
7	18,400	2.787	10	26,300	3.637
	18,600	2.817		26,500	3.648
	18,800	2.835		26,700	3.659
	19,000	2.861		26,900	3.671
	19,200	2.867		27,100	3.685
	19,400	2.893		27,300	
	19,600	2.925		27,500	3.707
	19,800	2.952		27,700	3.719
	20,000	2.966		27,900	3.731
	20,200	2.986		28,100	3.743
	20,400	3.007		28,300	3.758
	20,600	3.031		28,500	3.769
8	20,800	3.035	11	28,700	3.780
	21,000	3.060		28,900	3.788
	21,200	3.075		29,100	3.799
	21,400	3.095		29,300	3.809
	21,600	3.115		29,500	3.819
	21,800	3.137		29,700	
	22,000	3.185		29,900	3.839
	22,200	3.198		30,100	3.849
	22,400	3.210		30,300	3.859
	22,600	3.225		30,500	3.869
	22,800	3.240		30,700	3.879
	23,000	3.255		30,900	3.889
9	23,900	3.516**			
	24,100	3.523			
	24,300	3.533			
	24,500	3.543			
	24,700	3.553			
	24,900				
	25,100	3.573			
	25,300	3.584			
	25,500	3.595			
	25,700	3.605			
	25,900	3.616			
	26,100	3.626			

* Distance from Shot Point 2

** This and following travel-times are not first breaks

SEISMIC DATA - LINE B

Spread	Distance*	Time	Spread	Distance	Time
1	50	0.067	4	5,230	1.022
	100	0.099		5,409	1.047
	200	0.152		5,588	1.077
	300	0.207		5,767	1.107
	400	0.252		5,948	1.137
	500			6,125	1.162
	600	0.334		6,304	
	700	0.358		6,483	1.208
	800	0.372		6,662	1.231
	900	0.393		6,841	1.260
	1,000	0.405		7,020	1.288
	1,100	0.423		7,199	1.306
2	1,300	0.452	5	10,600	1.758
	1,395	0.469		10,800	1.778
	1,492	0.486		11,000	1.811
	1,593	0.497		11,200	1.828
	1,691	0.516		11,400	1.852
	1,791	0.528		11,600	1.883
	1,890			11,800	
	1,990	0.558		12,000	1.913
	2,090	0.573		12,200	1.928
	2,190	0.587		12,400	1.933
	2,290	0.597		12,600	1.947
	2,390	0.611		12,800	1.966
3	2,580	0.653	6	13,000	1.970
	2,769	0.675		13,200	1.985
	2,958	0.695		13,400	2.000
	3,147	0.723		13,600	2.020
	3,336	0.746		13,800	2.030
	3,525	0.768		14,000	2.055
	3,714			14,200	
	3,903	0.816		14,400	2.095
	4,092	0.838		14,600	2.115
	4,281	0.856		14,800	2.125
	4,470	0.888		15,000	2.137
	4,659	0.905		15,200	2.150

* Distance from Shot Point 2 at northwest end of line

Line B continued

Spread	Distance*	Time	Spread	Distance**	Time
7	15,400	2.136	1	1,300 NW	0.419
	15,600	2.186		1,200	0.399
	15,800	2.205		1,100	0.398
	16,000	2.245		1,000	0.388
	16,200			900	0.369
	16,400			800	
	16,600			700	0.334
	16,800	2.285		600	0.322
	17,000	2.309		500	0.300
	17,200	2.304		400	0.258
	17,400	2.315		300	0.209
	17,600	2.315		200	0.160
			2	200 SE	0.157
				300	0.208
				400	0.264
				500	0.304
				600	0.309
				700	0.318
				800	
				900	0.343
				1,000	0.345
				1,100	0.352
				1,200	0.365
				1,300	0.371
			3	1,300	0.370
				1,500	0.393
				1,700	0.418
				1,900	0.441
				2,100	0.458
				2,300	0.495
				2,500	0.524
				2,700	0.555
				2,900	0.584
				3,100	0.618
				3,300	0.645
				3,500	0.674

Distance between Shot Points 2 and 3: approximately 11,900'

* Distance from Shot Point 2

** Distance from Shot Point 3

Line B continued

Spread	Distance*	Time
1	205	0.092
	405	0.135
	605	0.162
	805	0.188
	1,005	0.218
	1,205	0.244
	1,405	0.275
	1,605	0.292
	1,805	0.318
	2,005	0.340
	2,205	0.378
	2,405	0.402
2	2,608	0.414
	2,808	0.446
	3,008	0.471
	3,208	0.496
	3,408	0.526
	3,608	0.553
	3,808	0.576
	4,008	0.606
	4,208	0.626
	4,408	0.647
	4,608	0.662
	4,808	0.685
3	6,008	0.808
	6,208	0.826
	6,408	0.842
	6,608	0.863
	6,808	0.888
	7,008	
	7,208	0.924
	7,408	0.948
	7,608	0.968
	7,808	0.990
	8,008	1.013
	8,208	1.038
	8,408	1.051
	8,608	1.083
	8,808	1.105
	9,008	1.129

Distance between Shot Points 2 and 4: approximately 21,208'

* Distance from Shot Point 4 at southeast end of line

SEISMIC DATA - LINE C

Spread	Distance*	Time
1	300	0.205
	500	0.298
	700	0.362
	900	0.402
	1,100	0.435
	1,300	0.471
	1,500	
	1,700	0.529
	1,900	0.563
	2,100	0.593
	2,300	0.628
	2,500	0.663
2	2,715	0.708
	2,915	0.763
	3,115	0.766
	3,315	0.798
	3,515	0.830
	3,715	0.861
	3,915	
	4,115	0.921
	4,300	0.945
	4,500	0.962
	4,700	0.996
	4,900	1.027
3	5,750	1.172
	5,945	1.201
	6,140	1.224
	6,335	1.253
	6,530	1.284
	6,725	
	6,920	1.330
	7,065	1.360
	7,260	1.382
	7,445	1.404
	7,640	1.441
	7,835	1.461

* Distance from Shot Point 2 at northeast end of line

Line C continued

Spread	Distance*	Time	Distance#	Time	Spread
4	8,035	1.500	3,377	0.539	2
	8,235	1.520	3,178	0.513	
	8,435	1.545	2,979	0.498	
	8,635	1.575	2,780	0.468	
	8,835	1.600	2,581	0.449	
	9,035	1.610	2,382	0.428	
	9,235		2,185		
	9,435	1.611	1,990	0.376	
	9,615	1.613	1,793	0.355	
	9.795	1.613	1,605	0.332	
	9,975	1.600	1,425	0.308	
	10,155	1.607	1,250	0.291	
			1,100	0.265	1
			1,000	0.249	
			900	0.230	
			800	0.213	
			700	0.204	
			600	0.191	
			500		
			400	0.137	
			300	0.117	
			200	0.079	
			100	0.038	
			25	0.015	
1**	51***	0.050	800##	0.359	1###
	151	0.137	900	0.358	
	251	0.191	1,000	0.364	
	351	0.232	1,100	0.372	
	451	0.279	1,200	0.374	
	551		1,300		
	651	0.298	1,400	0.374	
	751	0.286	1,500	0.374	
	851	0.283	1,600	0.349	
	951	0.277	1,700	0.354	
	1,051	0.270	1,800	0.349	
	1,151	0.276	1,900	0.349	

* Distance from Shot Point 2 at northeast end of line
# Distance from Shot Point 5 at southwest end of line
** Same recording location as Spread 1 for Shot Point 5
*** Shot Point 5a 51 feet northeast of spread
## Shot Point 5b 800 feet northeast of spread
### Same recording location as Spread 1 for Shot Point 5

SEISMIC DATA - LINE D

Spread	Distance*	Time	Spread	Distance**	Time
1	1,300 NE	0.380	1	1,300 SW	0.242
	1,200	0.361		1,200	0.240
	1,100	0.350		1,100	0.234
	1,000	0.340		1,000	0.233
	900	0.329		900	0.229
	800			800	0.232
	700	0.322		700	0.231
	600	0.309		600	0.226
	500	0.294		500	0.213
	400	0.243		400	0.208
	300	0.198		300	0.170
	200	0.149		200	0.125
2	420 SW	0.266	2	200 NE	0.111
	520	0.297		300	0.164
	620	0.326		400	0.215
	720	0.359		490	0.250
	820	0.380		590	0.263
	920			689	0.269
	1,020	0.409		788	0.279
	1,120	0.420		885	0.294
	1,220	0.438		980	0.314
	1,320	0.454		1,078	0.320
	1,420	0.464		1,175	0.328
	1,520	0.466		1,270	0.338
3	1,520	0.477	3	1,280	0.334
	1,720	0.487		1,477	0.353
	1,920	0.500		1,674	0.374
	2,120	0.520		1,871	0.384
	2,320	0.544		2,068	0.406
	2,520	0.570		2,265	0.419
	2,720	0.584		2,462	0.449
	2,920	0.603		2,659	0.468
	3,120	0.613		2,856	0.489
	3,320	0.636		3,056	0.506
	3,520	0.660		3,256	0.521
	3,720	0.676		3,456	0.540

Distance between Shot Points 3 and 6a: 5,000 feet

* Distance from Shot Point 3

** Distance from Shot Point 6a

Line D continued

Spread	Distance*	Time
1	3,380	0.412
	3,577	0.435
	3,774	0.452
	3,971	0.461
	4,168	0.485
	4,365	0.505
	4,562	0.525
	4,759	0.541
	4,956	0.561
	5,156	0.580
	5,356	0.591
	5,556	0.608

Distance between Shot Points 6 and 6a: 2,100 feet

Distance between Shot Points 3 and 6: 7,100 feet

* Distance from Shot Point 6 at southwest end of line

PUBLISHED GEOLOGICAL INFORMATION RELEVANT TO THE SAN JACINTO GROUND WATER BASIN

A brief abstract or comments follow some of the references. The references are presented in chronological order.

1857 Blake, W. P., Geological Report (Williamson's Reconnaissance in California) U. S. Pacific Railroad Exploration; U. S. 33rd Cong., 2d Sess., S. Ex. Doc. 78 and H. Ex. Doc. 91, Vol. 5, Pt. 2, 370 p.

Map 4, covering most of Southern California, is at a scale of 1:1,500,000.

1871 Guillemin-Tarayre, E., Description des Anciennes Possessions Mexicaines du Nord: Mission Scientifique au Mexique et dans 1' Amerique Centrale, Geologie Pt. 2, 216 p.

Plate 15 covers Southern California west of approximately 116° 50' west longitude at a scale of 1:1,000,000.

1886 Hanks, H. G., San Diego County: California Min. Bur. 6th Ann. Rept. Pt. 1, pp 80-90.

The map covers the southeastern half of the San Jacinto ground water basin at a scale of 1:375,000.

1893 Fairbanks, H. W., Geology of San Diego County; also portions of Orange and San Bernardino Counties: California Min. Bur. 11th Ann. Rept., pp 76-120.

The map covers almost all of the San Jacinto ground water basin at a scale of 1:375,000.

1899 The Riverside Press and Horticulturist, December 30th. A newspaper article describes the San Jacinto earthquake of December 25, 1899. The south walls of brick buildings "invariably went down, most of them falling outward."

1900 Claypole, E. W., The Earthquake of San Jacinto, December 25, 1899; Am. Geologist, Vol. 25, pp 106-108.

In Hemet, almost all brick buildings were severely damaged and only two chimneys remained standing. Six people were killed and eight injured at Soboba. Ten miles southeast of San Jacinto there were many fresh surface cracks and it is possible that the earthquake centered near here. Some damage was done to Riverside and the shock was distinctly felt at San Diego and at Seligman, Arizona. Aftershocks occured through May of 1900.

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1907 Danes, J. V., Das Erdbeben von San Jacinto am 25 December 1899; Mitteilungen der K. K. Geogr. Gesellschaft in Wien, Heft 6-7, pp 339-347.

A report of the San Jacinto earthquake of December 25, 1899.

1908 Lawson, A. C., and others. The California Earthquake of April 18, 1906; Carnegie Inst. Wash. Pub. 87, Vol. 1, 451 p.

This report of an earthquake investigation committee includes a reconnaissance of the San Andreas fault system. It shows the San Jacinto fault as a continuous break from the San Jacinto Valley to the Borrego Valley.

1908 Hess, F. L., The Magnesite Deposits of California; U. S. Geological Survey Bull. 355, 67 p.

The bulletin contains a brief description of the serpentine in the vicinity of the magnesite mine south of Hemet airport.

1912 Gale, Hoyt S., Late Developments of Magnesite Deposits in California and Nevada; U. S. Geological Survey Bull. 540, pp 483-520.

Gale's article contains more information on the magnesite mine south of Hemet airport. Figure 54 is a geological map at a scale of 1:13,500.

1915 Beal, Carl H., The Earthquake in the Imperial Valley, California, June 22, 1915; Bulletin of the Seismological Soc. of Am., Vol. 5, pp 130-149.

Beal maps the San Jacinto fault as a single fault line passing north of the town of San Jacinto, apparently at the southwest base of the mountains north of San Jacinto.

1918 Townley, Sidney D., The San Jacinto Earthquake of April 21, 1918; Bulletin of the Seismological Soc. of Am., Vol. 8, pp 44-62.

The article contains several pictures of the damage caused by this earthquake - and there was much damage. The quake was felt over all of Southern California and Western Arizona. Fortunately the quake occured on a Sunday afternoon so few people were in the business districts. Many injuries resulted but no deaths. The concrete road between Hemet and San Jacinto was cracked in thirteen places and the concrete road running northwesterly from San Jacinto was seriously cracked and buckled. Many live limbs were shaken from trees. A number of landslides occured in the San Jacinto mountains, one swept a car off the road. The ground was cracked in several places throughout the valley as were irrigation canals.

1918 Rolfe, Frank and A. M. Strong, The Earthquake of April 21, 1918, in the San Jacinto Mountains; Bulletin of the Seismological Soc. of Am., Vol. 8, pp 63-67.

A description of the earthquake effects on the area to the south and east of San Jacinto Valley is given.

1918 Arnold, Ralph, Topography and Fault System of the Region of the San Jacinto Earthquake; Bulletin of the Seismological So. of Am., Vol. 8, pp 68-73.

The main branch of the San Jacinto fault zone is located as passing through Hog Lake, the Blackburn ranch, by the northeastern side of Park Hill and under the town of San Jacinto.

1918 The Los Angeles TIMES, April 23, 1918.

A newspaper article describes the San Jacinto earthquake of April 21, 1918. "There were nine separate temblors over a period of thirty hours, beginning Sunday at 3:32 o'clock p. m."

1919 Waring, G. A., Ground water in the San Jacinto and Temecula Basins, California; U. S. Geological Survey Water Supply Paper 429.

Waring's water supply paper represents a detailed starting point of recorded information on the ground water of these two basins. It describes water use, quality, level, origin, and fluctuation. The likelihood of overdraft is pointed out and many well logs are presented.

1920 Hill, R. T., The Rifts of Southern California; Bulletin of the Seismological Soc. of Am., Vol. 10, pp 146-149.

Little new information is presented. Hill expresses his feeling that too much concern is given to the destructive effects of earthquakes.

1921 Frick, Childs, Extinct Vertebrate Faunus of the Badlands of Bautista Creek and San Timoteo Canyon, Southern California; Univ. Calif. Pub., Bull. Dept. Geol. Sci., Vol. 12, No. 5, pp 277-424.

A paleontological dating of the sediments of the badlands on the edges of the San Jacinto ground water basin is presented.

1924 Woodford, A. O., The Catalina Metamorphic Facies of the Franciscan Series; Calif. Univ. Dept. Geol. Sci. Bull., Vol. 15, No. 3, pp 49-68.

Figure 1 of Woodford's article is a geological map at a scale of 1:1,500,000 that includes portions of San Diego, Orange, and Riverside Counties. The northeastern corner of this map includes Winchester, Romoland, Homeland, and the Menifee areas. Since the publication of this article, more detailed mapping of these areas has been published.

1926 English, W. A., Geology and Oil Resources of the Puente Hills Region, Southern California; U. S. Geological Survey Bull. 768, 110 p.

In this bulletin English names the rather stable geologic area between the San Jacinto and the Elsinore fault zones the "Perris fault block." This is about the only item in the bulletin that is pertinent to the San Jacinto basin.

1928 Hill, R. T., Southern California Geology and Los Angeles Earthquakes; Published by Southern Calif. Acad. Sci., Los Angeles, 232 p.

Hill states that from 1780 to 1928 there were 170 reported shocks in Southern California; 92 on the San Jacinto rift, 16 on the San Andreas rift, 16 on the Elsinore rift, 14 near Inglewood, 2 near Los Angeles city and 30 shocks from distant localities.

1928 Post, W. S., Santa Ana Investigation, Flood Control and Conservation; California Div. Engr. and Irrigation Bull. 19, 367 p.

Map 14, at a scale of 1:250,000, includes most of the San Jacinto ground water basin.

1931 Fraser, D. M., Geology of San Jacinto Quadrangle South of San Gorgonio Pass, California; Mining in Calif. (Calif. Jour. of Mining and Geology,) Vol. 27, pp 494-540.

Though somewhat reconnaissant in coverage, this article, a condensation of Fraser's doctoral dissertation contains many observations of interest to any geological study in the area. His map is at a scale of 1:125,000 and extends as far west as 117° west longitude, approximately Sanderson Street.

1932 Sampson, R. J., Economic Mineral Deposits of the San Jacinto Quadrangle; Mining in Calif. (Calif. Jour. of Mining and Geology,) Vol. 28, pp 3-11.

The map scale is 1:125,000 and is of no interest to ground water studies.

1933 Murdoch, Joseph, Andalusite in Pegmatite; Am. Mineralogist, Vol. 21, pp 68-69.

Murdoch gives a discription of the pegmatites associated with the serpentines of the magnesite mine area south of Hemet airport.

1934 Eckis, R., South Coastal Basin Investigation; Geology and Ground Water Storage Capacity of Valley Fill; Calif. Div. Water Resources Bull. 45, 279 p.

Though this bulletin does not cover the San Jacinto ground water basin, Bean's estimate of the specific yield in the San Jacinto - Hemet area (Bean, 1955) is based on results of this bulletin.

1935 Sampson, R. J., Mineral Resources of a Portion of the Perris Block, Riverside County, Calif.; Calif. Jour. of Mines and Geology, Vol. 31, pp 507-521.

Though historically interesting, Sampson's article is of no interest to ground water studies.

1935 Dudley, P. H., Geology of a Portion of the Perris Block, Southern California; Calif. Jour. of Mines and Geology, Vol. 31, pp 487-506.

The major emphasis of Dudley's article is the igneous and metamorphic rocks, their petrology and the sequence of their emplacement.

1936 Dudley, P. H., Physiographic History of a Portion of the Perris Block, Southern California; Jour. Geol., Vol. 44, pp 358-378.

In order to understand the more recent geological history of the Perris Block, this article examines the erosional and fault land forms. It is an assistance in understanding the bedrock features below the valley sediments.

1937 Axelrod, D. I., A Pliocene Flora from the Mt. Eden Beds, Southern California; Carnegie Inst. Washington, Pub. 476, pp 125-184.

The badland sediments north of the San Jacinto Valley are dated with the aid of plant fossils.

1939 Henderson, L. H., Detailed Geological Mapping and Fault Studies of the San Jacinto Tunnel Line and Vicinity; Jour. Geol., Vol. 47, pp 314-324.

Over twenty faults, parallel or subparallel to the San Jacinto fault zone, are mapped and their effect on the San Jacinto tunnel is reported. These faults produced much water and caused severe problems during the driving of the tunnel.

1939 Osborn, E. F., Structural Petrology of the Val Verde Tonalite, Southern California; Geol. Soc. America Bull., Vol. 50, pp 921-950.

The basement rock west of a portion of the Perris sub-basin of the San Jacinto ground water basin is examined in this article.

1939 Webb, Robert W., Evidence of the Age of a Crystalline Limestone in Southern California; Jour. Geol., Vol. 47, pp 198-201.

Webb found Carboniferous (Mississippian) fossils in the limestone interbedded with the schists north and south of Domenigoni Valley and thus helped date the older metamorphic rocks around and below part of the San Jacinto basin.

1948 Larsen, E. S., Jr., Batholith and Associated Rocks of Corona, Elsinore, and San Luis Rey Quadrangles, Southern California; Geol. Soc. America Mem. 29, 182 p.

Most of the information of Larsen's memoir is contained in his 1951 Calif. Div. of Mines bulletin.

1949 Sprotte, E. C., The San Andreas and San Jacinto Fault Zones; Sigma Gamma Epsilon, The Compass, Vol. 26, pp 315-319.

1950 Axelrod, D. I., Further Studies of the Mt. Eden Flora, Southern California; Carnegie Inst. Washington, Pub. 590, pp 73-118.

1951 Larsen, E. S., Jr., Crystalline Rocks of the Corona, Elsinore, and San Luis Rey Quadrangles, Southern California; Calif. Div. of Mines bulletin 159, pp 7-50.

The petrology and relative age of the basement rocks are discussed in detail but little information is presented about the faults and almost no information about the water bearing sediments. Larsen's map is at a scale of 1:125,000 and indicates the type of exposed crystalline rocks in and around the portion of the San Jacinto ground water basin that is west of 117° west longitude (approximately Sanderson Street.) Larsen's work can be of assistance in obtaining estimates of the relative permeabilities of the crystalline rocks.

1954 Jahns, R. H., Geology of the Peninsular Range Province, Southern California and Baja California; Calif. Div. of Mines Bull. 170, Chapter II, pp 29-52.

The San Jacinto ground water basin is in the northern part of the Peninsular range. Jahns' article gives a clear understanding of the geological framework of which the San Jacinto basin is a small part.

1954 Jahns, R. H., Northern Part of the Peninsular Range Province; Calif. Div. of Mines Bull. 170, Geologic Guide No. 5, 59 p.

This guide book presents a tour of the geology surrounding, but not including, the San Jacinto ground water basin. It is accompanied by several geologic maps.

1954 Gray, Cliffton H., Geology of the Corona-Elsinore-Murrieta Area, Riverside County; Map Sheet No. 21, Calif. Div. of Mines Bull. 170.

This includes the southwestern portion of the San Jacinto ground water basin. This portion of the map is based on Dudley (1935 and 1936) and Larsen (1948) and little or no new information is presented.

1955 Kundert, C. J., Santa Ana Sheet; Geological Map of California, Calif. Div. of Mines.

In the area of the San Jacinto ground water basin this map is based on Larsen (1951) and Fraser (1931) and no new information is presented. The scale is 1:250,000. The map has been reissued in 1965 and contains more detailed information. See 1965, Rogers.

1955 Bean, Robert T., Geology of San Jacinto and Elsinore Basins, Appendix B, Santa Ana River Investigation; Bulletin No. 15, Calif. State Water Resources Board, 88 p.

Bean's report covers in detail the ground water geology and geology of the water bearing sediments. The areal geology of the crystalline rocks is based on previous work by other geologists.

1959 Engel, Rene, Geology and Mineral Deposits of the Lake Elsinore Quadrangle, California; Calif. Div. of Mines Bull. 146, 154 p.

Bulletin 146 just touches the southwestern corner of the San Jacinto ground water basin near Railroad Canyon reservoir. In that area the igneous and metamorphic rocks are mapped in somewhat more detail than by Larsen (1951.) Engel's Santa Ana formation is called Bedford Canyon formation by Larsen and most other geologists. The map scale is 1:62,500.

1962 Proctor, R. J., Geologic Features of a Section Across the Casa Loma Fault, Exposed in an Aqueduct Trench Near San Jacinto, California; Geological Soc. Am. Bull., Vol. 73, pp 1293-1296.

Evidence of very recent movement of the Casa Loma fault is reported.

1964 Eaton, G. N., Martin, and M. A. Murphy, Application of Gravity Measurements to Some Problems in Engineering Geology; Engineering Geology, Vol. 1, No. 2, pp 6-21.

Northeast of Perris a gravity survey was performed. Knowing the depth to basement rock from test hole information and knowing the density of basement rock and the grain density of the sediments, it was possible to estimate the porosity of the sediments. A porosity of 36 to 40 percent was indicated.

1965 Rogers, Thomas H., Santa Ana Sheet; Geologic Map of California, Calif. Div. of Mines.

Rogers compiled this geologic map and did some of the mapping. The San Jacinto basin portion of the map is based primarily on Bean's 1955 work.

1967 Fett, J. D., D. H. Hamilton, and F. A. Fleming, Continuing Surface Displacements Along the Casa Loma and San Jacinto Faults in San Jacinto Valley, Riverside County, California; Engineering Geology, Vol. 4, No. 1, pp 22-32.

Displacement and pipeline and road fracturing along these faults are reported. The City of San Jacinto subsided more than a foot in the period 1932-1964. More recent work establishes the cause of current subsidence to be ground water withdrawal (Fett and Hamilton, in preparation and to be submitted to Engineering Geology.)

1967 Sharp, Robert V.. San Jacinto Fault Zone in the Peninsular Ranges of Southern California; Bull. Geol. Soc. Am., Vol. 78, No. 6, pp 705-730.

This paper is based on Sharp's doctoral dissertation. The San Jacinto fault zone and adjacent geology have been investigated from the southeast end of San Jacinto Valley to the Borrego Valley area. Fifteen miles of right-lateral displacement has occured as well as one to two miles of vertical displacement, the northeast side dropping with relation to the southwest side.

APPENDIX NO. 2

TEMPERATURE STUDY OF SPREADING PONDS

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TEMPERATURE STUDY OF SPREADING PONDS

by

J. H. Birman and A. B. Esmilla
Geologists

for

EASTERN MUNICIPAL WATER DISTRICT
SAN JACINTO, CALIFORNIA

Geothermal Surveys, Inc.
Los Angeles, California 90065
December 30, 1970

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TEMPERATURE STUDY OF SPREADING PONDS
EASTERN MUNICIPAL WATER DISTRICT
SAN JACINTO, CALIFORNIA

INTRODUCTION

Purpose and Scope

This report describes the results of a temperature study made at San Jacinto, California through the period September 1969 to September 1970. The principal objective was to provide additional information on fluid migration from the spreading ponds of the Eastern Municipal Water District. The study made use of ground temperatures and temperature gradients in boreholes at several times during the year. The temperature data were analyzed in terms of source, physical setting, and related parameters such as water quality and electrical resistivity in wells.

Setting

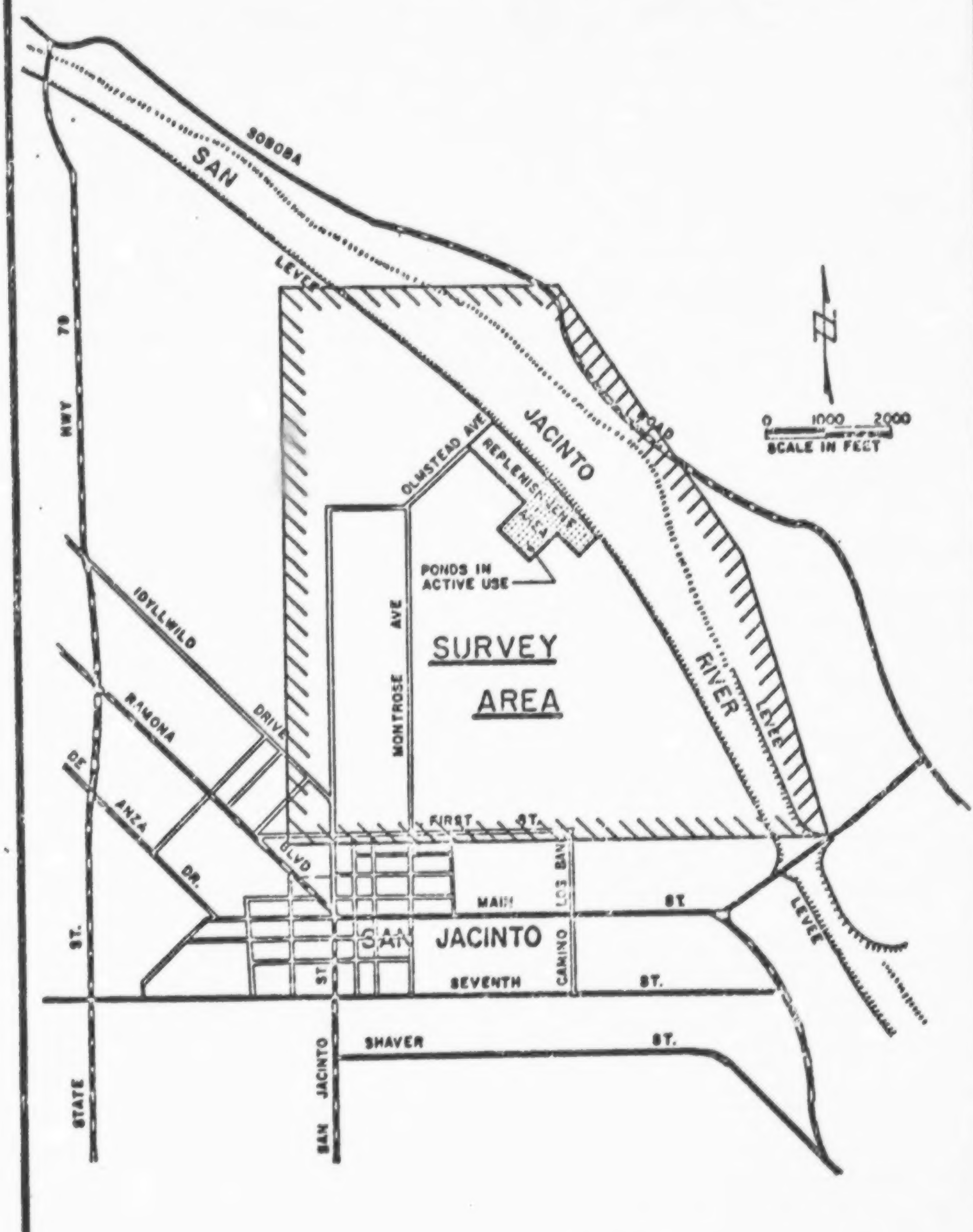
The surveyed area (Figure 1) is in the flood plain of the San Jacinto River. The main channel of the San Jacinto River flows northwesterly between the spreading grounds and the rugged San Jacinto Range, about half a mile to the northeast. The spreading grounds are on a plain which slopes about 30 feet per mile northwesterly, and which is less than 10 feet above the river channel. Portions of the active channel are adjacent to the spreading grounds.

The northwestern part of the survey area consists of pasture land and fallow ground. Much of the remaining survey area is farmed and irrigated.

The San Jacinto fault zone passes between the spreading grounds and the San Jacinto Range. Soboba Hot Springs and other thermal springs occur along the fault traces, and many truncated spurs occur along the front of the San Jacinto Range.

The survey area is underlain by unconsolidated sand although occasionally gravel and boulders were encountered during drilling for the thermal survey. The river channel deposits are mostly medium to coarse sand. The deposits beneath the channel and beneath the adjacent plains to the west are medium to fine sand, increasing in silt and clay layers downward.

Ground water occurs at depths of the order of 30 feet in and


SOBOBA
SAN
LEVEE
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ROAD
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SCALE IN FEET
HWY 79
OLMSTEAD AVE
REPLENISHMENT AREA
PONDS IN ACTIVE USE
SURVEY AREA
MONTROSE AVE
IDYLLWILD DRIVE
RAMONA BLVD
DE ANZA DR.
FIRST ST.
MAIN ST.
LOS BAN
CAMINO
SAN JACINTO
SEVENTH ST.
SHAVER ST.
STATE ST.
SAN JACINTO ST.
LEVEE

FIGURE I. GEOTHERMAL SURVEY AREA

along the river channel and at about 200 feet depths beneath the plain to the west. The water in the river channel deposits may thus be perched above the main ground water table.

The annual rainfall in the San Jacinto area is about 13 inches. The average annual temperature is about 63°F (17°C).

Spreading Ponds

As shown in Figures 1 and 4, the northwest segment of the reclamation area is not in active use. Beginning in January 1970, the EMWD instituted a revision in the recharge cycle due to decreased effluent flows. Basins 1 through 4 receive one day's flow per week and basins 5 and 6 then receive the flow for the other three days.

The flow to the basin is about 1.5 acre-feet per day. The temperature of the effluent ranges from 70°F (20.7°C) to 85°F (29.2°C). In September 1970, the average effluent temperature was 82°F (27.8°C).

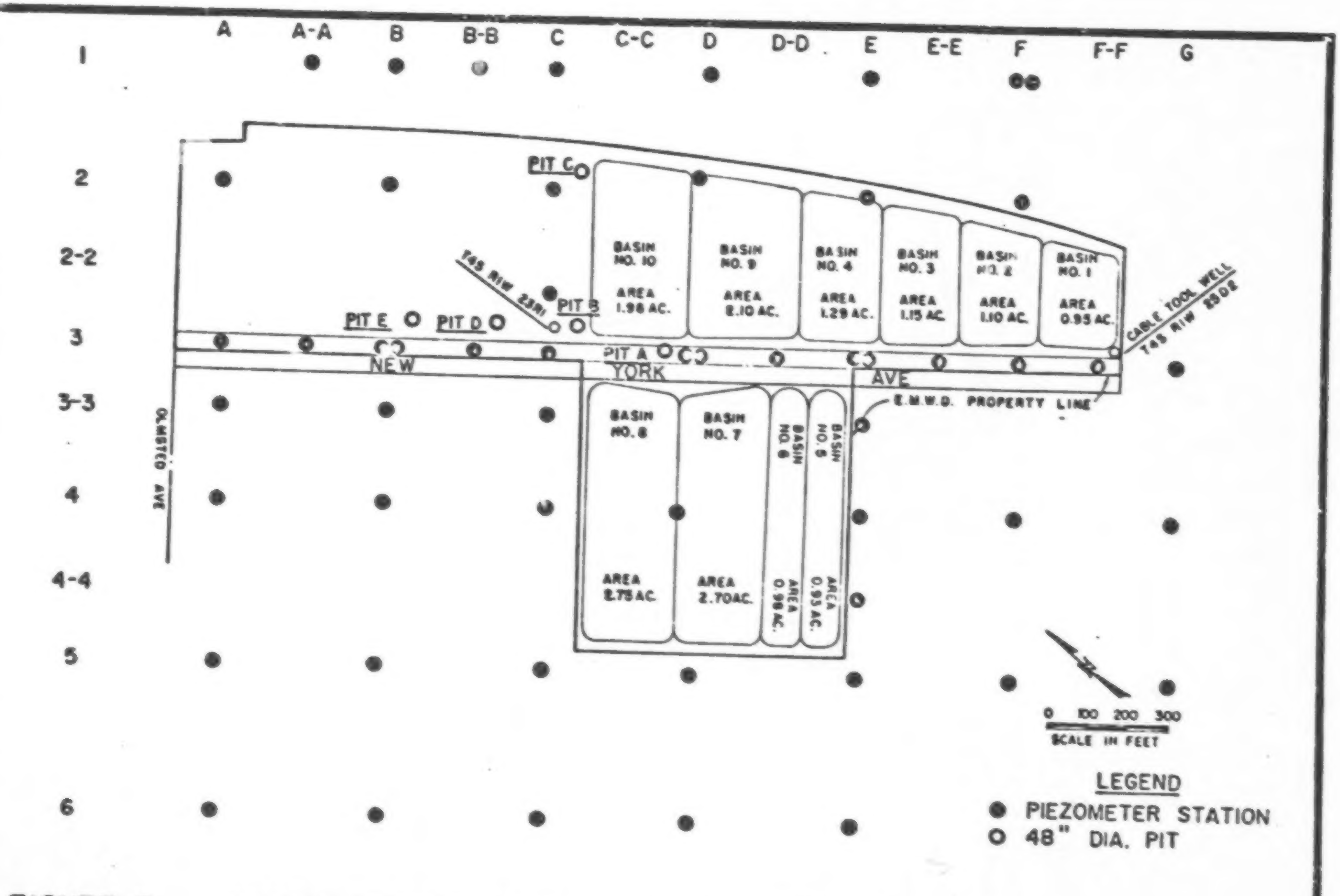
Method

Ground temperatures were obtained by using thermistor probes calibrated to .01°C. The probes were inserted in small diameter holes drilled to depths of 7 to 10 feet and backfilled to avoid surface-derived temperature effect. After preliminary observation, the reading depths were standardized to 8-1/2 feet. Temperature profiles in wells and drillholes were made with a thermistor cable.

Probe stations could not be located in a precisely uniform pattern because access was limited. Several previously planned probe stations were not able to be drilled because of objections by property owners and difficulty of drilling. Most probes were spaced about 1000 feet apart during the early phase of the work. The later part of the survey utilized existing piezometer holes closer to the spreading ponds, spaced about 500 feet apart.

Interpretations utilized both the temperature and the temperature drift in response to the annual cycle.

Sets of readings were made at several different times of the year. As the work progressed unessential probe stations were eliminated and others were added in localities where more information was needed. Table I is a chronological summary of the investigation.


A
A-A
B
B-B
C
C-C
D
D-D
E
E-E
F
F-F
G
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2
2-2
3
3-3
4
4-4
5
6
PIT C
PIT B
PIT D
PIT E
PIT A
T4S R1W 23R1
CABLE TOOL WELL
T4S R1W 23D2
NEW
YORK
AVE
OLMSTED AVE
E.M.W.D. PROPERTY LINE
BASIN NO. 10
AREA 1.98 AC.
BASIN NO. 9
AREA 2.10 AC.
BASIN NO. 4
AREA 1.29 AC.
BASIN NO. 3
AREA 1.15 AC.
BASIN NO. 2
AREA 1.10 AC.
BASIN NO. 1
AREA 0.95 AC.
BASIN NO. 8
AREA 2.75 AC.
BASIN NO. 7
AREA 2.70 AC.
BASIN NO. 6
AREA 0.98 AC.
BASIN NO. 5
AREA 0.93 AC.
0
100
200
300
SCALE IN FEET
LEGEND
● PIEZOMETER STATION
○ 48" DIA. PIT

FIGURE 2. PIEZOMETER NETWORK & 48-INCH DIAMETER PIT LOCATIONS

TABLE I

CHRONOLOGICAL SUMMARY OF TEMPERATURE SURVEY

Date	No. of Probes Used in Ground Survey	Wells or Boreholes Surveyed	Comments
1969 Sept. 3	37	-	Arealsurvey. Basic pattern established.
1969 Sept. 19	40	-	-do-
1969 Nov. 3	-	25D2,6	Vertical gradients; temperature of the ground water
1969 Dec. 16,17	40	-	Areal survey. Related temperature to water quality.
1969 May 6	44	6,7 (water temperature only)	Areal survey. Eliminated remote probe stations. Used 19 additional locations at piezometer stations within 1000 feet of the ponds.
1970 July 7	19	-	Two downstream temperature profiles across the San Jacinto River
1970 July 8	1,9,10		Vertical gradients; temperature of ground water.
1970 Sept. 22,23	46	-	Areal Survey; comparison with September 19, 1969
1970 Sept. 27	-	25D2,3,6, 7,9,10,12, 13	Vertical gradients; temperature of ground water.

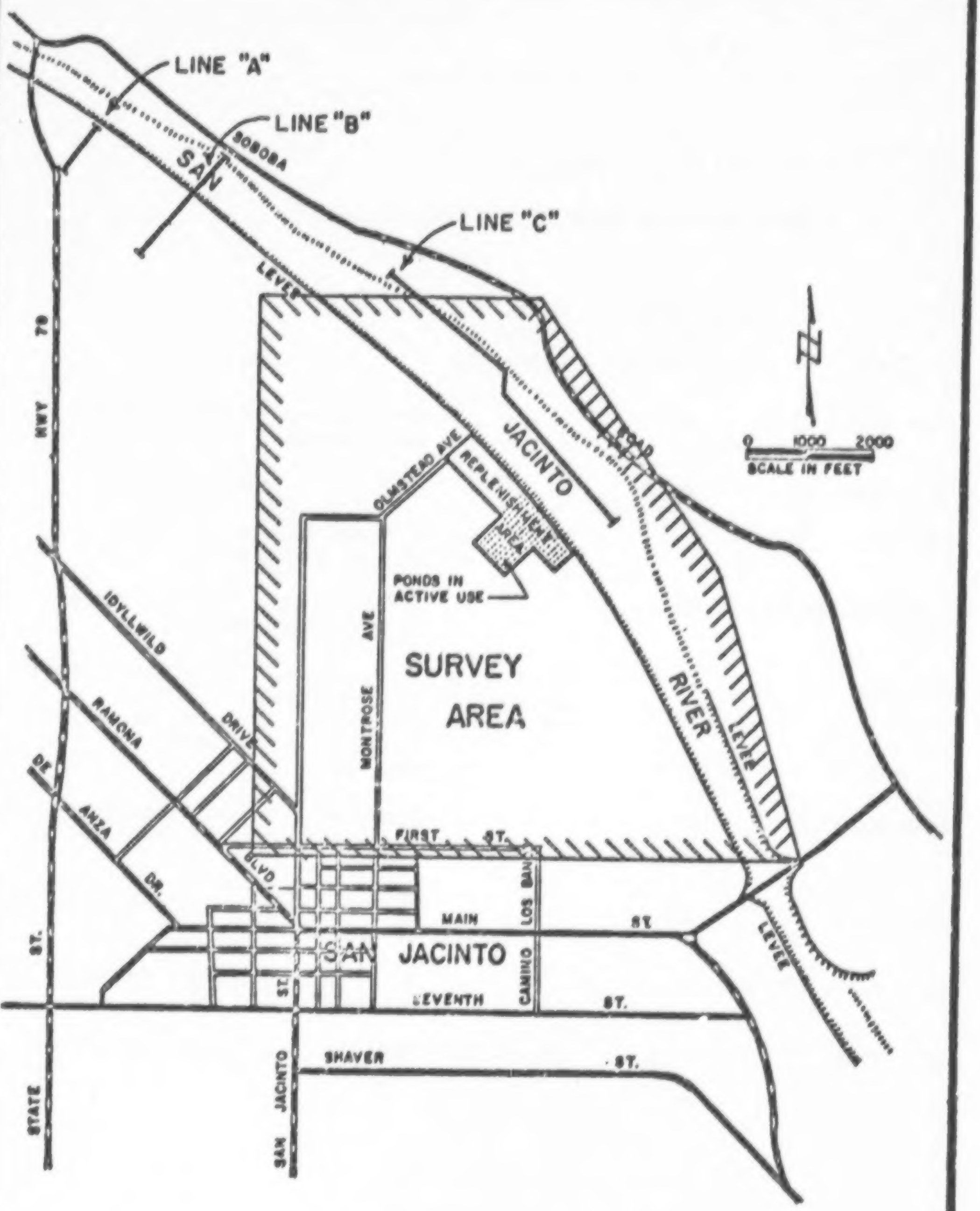

LINE "A"
LINE "B"
LINE "C"
SOBOBA
SAN
JACINTO
RIVER
LEVEE
LEVEE
LEVEE
ROAD
N
0 1000 2000
SCALE IN FEET
HWY 79
STATE ST.
IDYLLWILD DRIVE
RAMONA BLVD
DE ANZA DR.
OLMSTEAD AVE
REPLENISHMENT AREA
PONDS IN ACTIVE USE
MONTROSE AVE
SURVEY AREA
FIRST ST.
MAIN ST.
CAMINO LOS BAN
SAN JACINTO
SEVENTH ST.
SHAVER ST.
SAN JACINTO ST.

FIGURE 3. TEMPERATURE PROFILE LINES – SURVEYED JULY 7 AND 8, 1970

GROUND TEMPERATURE SURVEY

General Statement. In using temperature to trace ground water movement, we observe the temperature of the fluid in comparison with the background temperature. In the San Jacinto study there are several thermal regimens which must be considered. In addition to the fluid from the spreading ponds, there are: (1) the normal background temperature throughout the plain south, west and northwest of the ponds; (2) the temperature system of the San Jacinto River channel; and (3) the temperatures associated with the San Jacinto Fault traces.

The temperatures found in and near the San Jacinto River channel were found to be the coldest at all times of the survey. Background temperatures in the plain were found to be warmer. Some of the temperatures on the east side of the San Jacinto River were also found to be warm and, from vertical gradient evidence, may relate either to shallow crystaline bedrock or to the San Jacinto Fault. In all five areal surveys, the highest temperatures were found in or adjacent to the reclamation area.

Plates 1 to 5 are the thermal maps for each time of survey. Most of the differences in complexity of thermal topography are due to greater density of probes during the later portion of the survey period. Some differences in the plain area result from changes in pattern of irrigation. Although the thermal surface rose and fell in response to the annual cycle, the major thermal relief elements largely persisted in relative position and value. This can be seen by inspection, and it was also tested by contouring the last survey using only the probe locations of the previous year. This map, not included in this report, showed good similarity with that of the previous year, both in thermal configuration and in actual temperature values. The results, therefore, show reasonable good internal consistency.

In summary, the following statements can be made for each of the five ground temperature surveys:

1. The strongest thermal anomaly in the entire survey area was found at the spreading grounds, particularly in the southern part.

2. The type of anomaly was warm .

3. The thermal relief throughout the surveyed area was larger than we have found in most areal studies.

4. As expected, the coldest temperature readings were from localities in and near the San Jacinto River channel.

5. The thermal pattern was time persistent, as indicated by more than one set of temperature readings.

6. The temperature of the deep ground water is colder than the ground temperatures at shallow depth, i.e. the normal thermal gradient is reversed.

The following sections describe the results of each of the ground temperature surveys.

September 3 and 19, 1969. The temperature maps (Plates 1 and 2) show strong relief consisting of several high and low temperature zones and a very marked temperature decline toward the San Jacinto River. There is a strong similarity of the gross and detailed characteristics of the two thermal maps. The highest thermal relief, on the order of 3 or 4 Centigrade degrees, occurred at the southeastern end of the pond area. In this vicinity, the ground water table (well 25D2) was at 226 feet below the ground surface.

The area of highest thermal relief was also characterized by negative temperature drift (temperature difference between the two sets of readings) or a temperature drop in contrast to the other parts of the survey area, which showed positive temperature drift or warming. The high thermal regimen in the southeastern end of the pond area could have been caused by solar heating of the effluent before percolation into the ground.

At the time of the September 1969 surveys, some of the thermal relief in the background area west and south of the ponds was thought due possibly to flow from the ponds, in addition to other explanations. It is now believed that these thermal features related to pattern of irrigation (as at probe station 36) and to irregularities in the ground water table because of pumping.

A gully-like thermal low trended north along the western edge of the spreading grounds (probe stations 13 and 8). This feature persisted in the later surveys and it is now believed related to the San Jacinto underflow as explained later.

The continuous strong thermal slope shown extending from the west to the east bank of the river was not considered reliable. This was borne out by the later surveys which showed a very complex pattern when additional probes were used.

These surveys did not show extensive lateral migration from the spreading ponds.

December 16 and 17, 1969. The results of the survey are shown in Plate 3. Lateral migration from the reclamation area again did not seem to be extensive. The affected area in December was believed not to extend beyond the dashed line shown in Plate 3. This is an outside limit and it may not have been reached at all times.

Variation in flow pattern at different times is indicated by differences between the September and December readings.

In September, the maximum thermal anomaly was in the vicinity of the southeastern part of the reclamation area, near Basins 1-3. In December, the maximum anomaly had moved to the southwestern part, near Basin 7. This may have resulted by variation in use of the individual basins.

The very large thermal relief, varying to as much as 6 Centigrade degrees, suggested distinctly different thermal systems. The coldest temperatures in the reclamation area again indicated two shallow systems: the channel flow of the San Jacinto River and the effluent in the spreading grounds. The thermal effect of the San Jacinto River was so strong that shallow underflow was indicated. This in turn suggested that high water levels in some piezometer and observation holes away from the reclamation area were due not to infiltration of effluent but to lateral migration from the channel of the San Jacinto River.

In the December survey, the moderate temperature at probe station 7 drew the reclamation area contour pattern across the San Jacinto River. This was not considered reasonable, as the temperature at station 7 was thought to be related to the temperature regimen on the east side of the river. The later surveys, using more probes, confirmed that a high temperature zone does not extend across the river from the spreading ponds.

The results of this study, combined with other supportive information (discussed in the later sections), indicate that lateral migration from the spreading ponds was not extensive. Subsurface migration of the effluent appeared to be mostly to the San Jacinto River channel, although possibly with some migration westward into the ground water deepened by extensive well production.

The setting is best visualized as a normal high ground water table (or high perched water) under the San Jacinto River channel and throughout a zone 1000 to 2000 feet wide extending along the western margin of the river. Farther west this high water is depleted or irregularly deepened by agricultural and domestic well production. The spreading grounds are situated within the zone of high standing subsurface water, and superimpose a still higher rise configuration upon it. The actual pattern of the superimposed mound appears to be very complex in detail and very variable in time.

May 6, 1970. Plate 4 shows the results of the fourth areal ground temperature survey in the spreading area. Unlike the previous three temperature surveys which included probe stations in the outlying areas, this survey was confined more closely to the vicinity of the reclamation area. In addition to the old probe stations in the survey area, nineteen of the piezometers were utilized as probe stations and nine new probe stations were located in the San Jacinto River channel. A few of the original probe stations had been lost due to farming activities, but nearby piezometers were able to be used in lieu of the lost stations.

During this survey, potato fields south and southeast of the reclamation area were being irrigated. Effluent was being pumped into Basins No. 6 and No. 7.

This survey clearly established that the coldest temperatures in the survey area are in or adjacent to the San Jacinto River channel zone. As had been anticipated, the moderate thermal ridge which in the previous reports appeared to extend from the spreading ponds toward Observation Hole No. 3, was now shown not to exist. The subsurface flow of the river was now more clearly delineated by a series of strong thermal lows within the channel and extending laterally beneath part of the spreading pond area. The moderately low temperature zone was still present through the northwestern part of the reclamation area in the location of probe stations 13, 8, and several new probe stations nearby.

The highest temperatures obtained at this time were again clearly associated with the spreading ponds, and with the basins being used at the time. It appeared that the effluent was continuing to modify the temperatures of the two adjacent systems, as shown by the configuration of the contours.

In view of the very cold temperature pattern in the San Jacinto River channel, implying active underflow, it is reasonable to expect that much of the recharged effluent was being flushed along into the underflow. The cool temperatures northwest of and beneath part of the reclamation area suggested that some of the shallow underflow extended laterally into the adjacent banks. Temperatures were still low in the area of the previous thermal trough at probe stations 13 and 8, but now with increased density of probes, the axis shifted southeast beneath the reclamation area. The strong thermal depression at probe station 20 may have been due partly to irrigation.

The exact configuration of subsurface flow in the river channel was now known, as close spacing of thermal probes did not extend northwest of station 8 nor throughout the eastern half of the channel. Closure of the main thermal depression may not have been real, unless warming by the effluent and/or by fault-related thermal waters was sufficient to mask the colder temperatures of the river.

July 7 and 8, 1970. Three temperature profiles were made (profile lines A, B, and C, Figure 3). The objective was to test whether the low temperatures indicative of shallow underflow of the San Jacinto River could be traced downstream. Lines A and B used respectively three and nine probe stations. There were seven stations along line C, utilizing existing piezometers and some of the probe stations of the earlier survey. Line C provided a reference tie between the two downstream profiles and the area previously surveyed.

Lowest temperatures were found within the existing river channel and at the extreme southwest ends of lines A and B. Higher temperatures were found within a zone about 500 feet wide extending along the southwest side of the river. This zone is in line with a northwest-trending zone of temperature highs shown in Plate 4 at probe stations 9 and 2. The temperatures in all three profiles ranged from 17.0°C to 21.2°C. The lowest temperatures along profiles A and B (17.2°C-17.4°C) compared well with the lowest temperatures (17.0°C) along profile C.

Results of the July survey indicated that shallow underflow continued downstream, and that unless local non-river effects were operating at the southwest ends of the profiles, underflow is not completely confined to the channel. Moreover, if the zone of thermal highs is truly continuous northwesterly from the spreading ponds area, the overall temperature pattern may be responding to a hitherto unrecognized trace of the San Jacinto fault.

TABLE II

WELLS THERMALLY LOGGED

Well or Drillhole No.	Diameter of Casing (in.)	Total Depth (feet)	Perforated at (feet)	Static Water Level (feet)
25D2	12	820	170-300 345-355 395-405 445-455 500-600 645-655 695-705 745-755 795-805	226.4 227
1	2	160	60-80 100-120 140-160	50.5
3	2	160	60-80 100-120 140-160	48.0
6	2	260	200-220 240-260	29.5, 35.3
7	2	260	200-220 240-260	105, 98, 102.8
9	2	260	200-220 240-260	48.5 32.4
10	2	260	200-220 240-260	36.5 30.3
12	2	470	-	182.2
13	2	710	-	60.0

September 22 and 23, 1970. Plate 5 shows the results of the last ground temperature survey. This was an anniversary survey made to compare with the results of September 19, 1969. Because of greater probe density in and near the reclamation area, the 1970 map shows much greater thermal complexity.

The highest and lowest temperatures in the entire survey were again found respectively in the reclamation area and in the river channel. The positions of the highest temperature anomalies, in the area of basins 5, 8, and 10, are believed due to thermal lag, having been warmed by the summer recharge and not yet cooled by the September effluent which was being discharged in basins 1-6, the only ones active since January 1970.

The moderate to strong thermal depressions southwest of basins 1-4 and northwest of basin 8 are believed due to underflow from the San Jacinto River, as no irrigation was in progress at the time of survey. If this is correct, these effects have probably masked some of the thermal pattern due to spreading from the ponds. Moreover, because of inaccessibility for locating probes, the exact thermal configuration is not known within the area of basins 1-4. With these considerations it is reasonable to believe that the inner and outer limits of fluid migration are as shown by the dashed lines on Figure 4. Corresponding areas drawn for the previous surveys would be grossly similar but not identical. It is believed that the pattern of fluid migration is complex and that it changes through time.

TEMPERATURE GRADIENTS

General Statement. Downhole temperature profiles were made in the deep well 25D2 and in several of the observation holes (Table II and Figure 4). The objective was to investigate the ground water temperatures and to test for any thermal effects in the observation holes which might result from spreading. This was only a partial program, and the results must be considered incomplete. Nevertheless, some of the findings are believed to be significant. Table II presents the characteristics of the holes surveyed.

Results. Figures 5, 6, and 7 present the results of the downhole temperature studies during the survey period. Observation points were at 10 to 25 foot intervals in the holes.

The deep well 25D2 (Figure 6) serves as an excellent reference for ground water conditions in the immediate vicinity of the spreading ponds. Here the ground water table is at 226 to 227 feet. The temperature at the ground water table is 17.2°C, which is several degrees colder than the temperature of the effluent and any of the temperatures observed in the ground temperature survey. The gradient below about 60 feet is reversed, i.e. the temperature becomes colder with depth. Only in the lower portion of the well does the temperature increase in response to the deep geothermal gradients. From the ground surface to about 60 feet depth, very large temperature swings were observed between the two times of survey. Below 60 feet, the profiles are remarkably similar, both in form and in actual temperature, even though the two profiles were measured almost a year apart. It seems reasonable, therefore, that the effects of lateral spreading from the ponds are limited to within 60 feet of the surface.

The profiles in observation holes 1 and 3 are significantly different from those in all the other holes surveyed. The gradients are positive, except for the segment between 20 and 38 feet in observation hole 3. The temperatures in both holes in the air and water columns are about 2-1/2 degrees warmer than in the other holes. These holes are on the east side of the San Jacinto River, close to the bedrock of the San Jacinto Range. They are interpreted as being outside the active flow zone of the San Jacinto River and they may be influenced by heat from the crystalline basement, the San Jacinto fault, or both.

In observation holes 6 and 7, the gradients are again reversed. The ground water temperature in hole 7 is very similar to that in hole 25D2, although the static water level in hole 7 is at 102.8 feet, about 124 feet higher than in hole 25D2. In observation hole 6, the static water level is at only 35 feet, and the temperature of the water is about 1-1/2 degrees warmer. Perforations in the casings of all three holes begin downward from about 200 feet. Therefore, the widely different water levels cannot be easily explained. The logs of the drill holes show much alternation of sand, silt, and clay beds. Vertical permeability is probably much more difficult than horizontal permeability, and a complex system of perched lenses can be expected.

Observation holes 1 and 3 both show similar gradients, with good repeatability between the July and September surveys. The gradients below the water table are positive, and although the static water levels are shallow, the temperatures are very similar to those in well 25D2. The strong

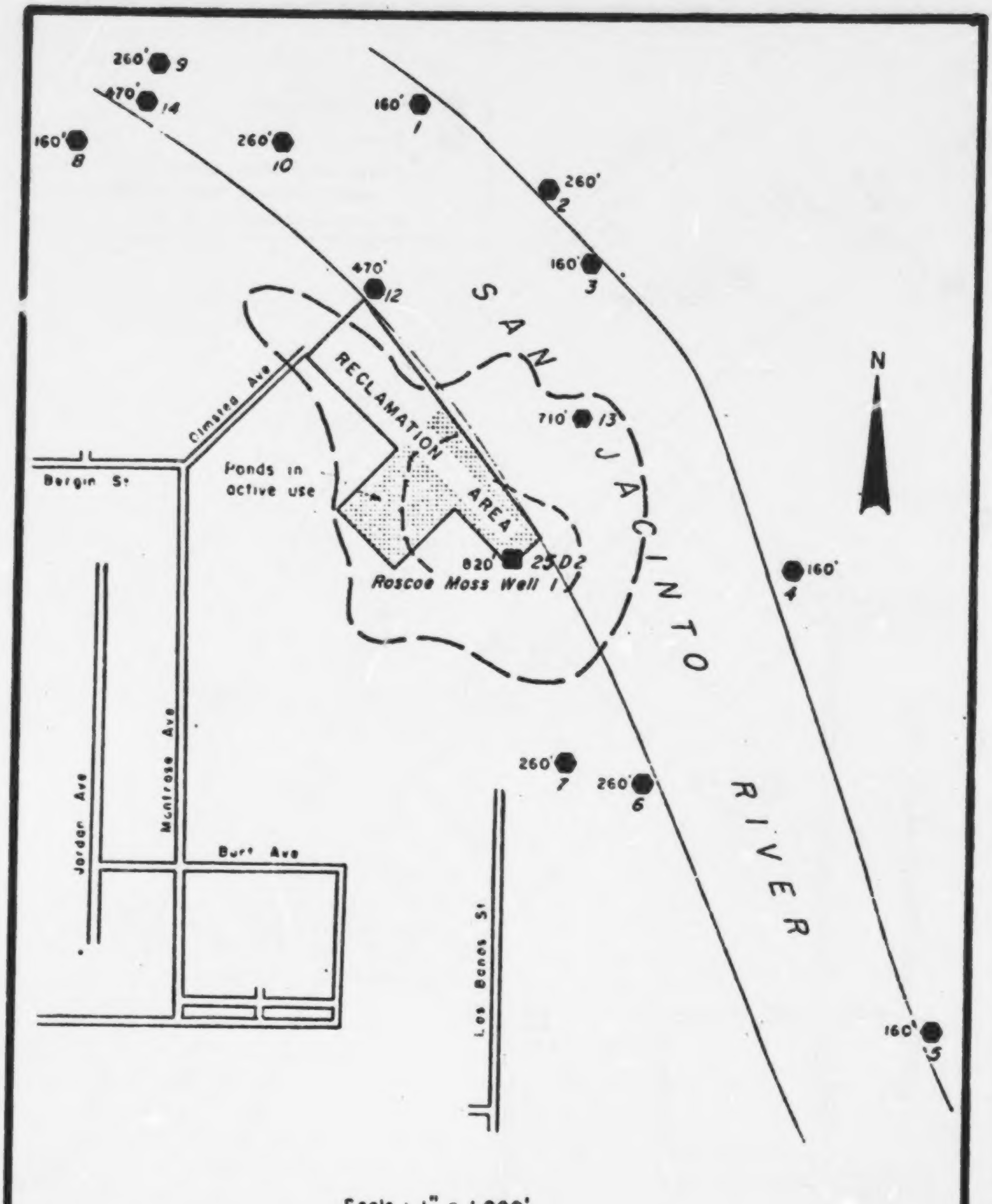

260' 9
470' 14
160' 8
260' 10
160' 1
260' 2
160' 3
470' 12
SAN JACINTO RIVER
N
RECLAMATION AREA
Ponds in active use
Olmsted Ave
Bergin St
710' 13
820' 25D2
Roscoe Moss Well 1
160' 4
260' 7
260' 6
Jordan Ave
Montrose Ave
Burt Ave
Los Banos St
160' 5
Scale · 1" = 1,000'

FIGURE 4. LOCATION AND DEPTH OF DRILLHOLES AND LIMIT OF ZONE OF INFLUENCE

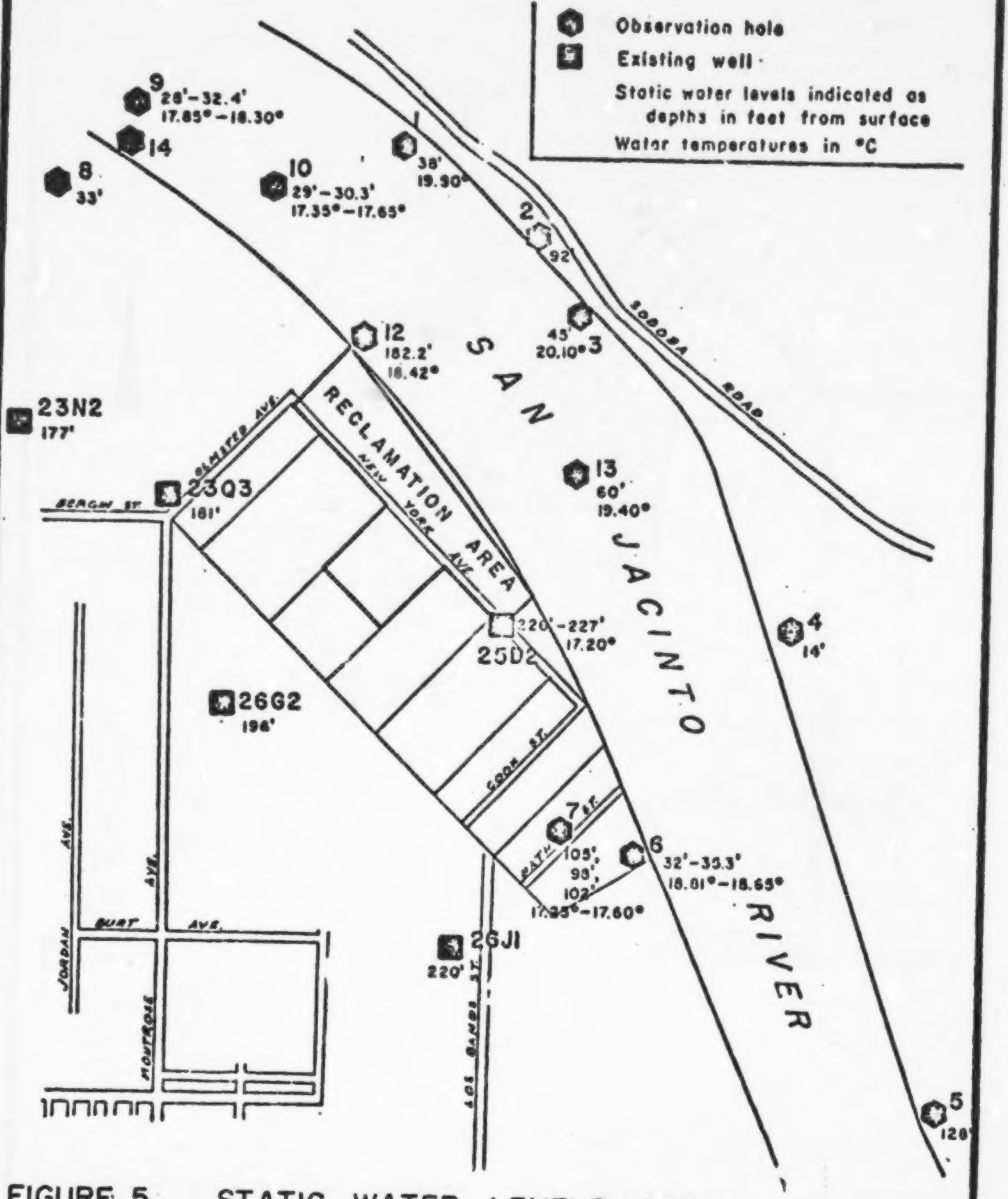

Observation hole
Existing well
Static water levels indicated as depths in feet from surface
Water temperatures in °C
9
28'-32.4'
17.85°-18.30°
14
8
33'
10
29'-30.3'
17.35°-17.65°
38'
19.30°
2
92'
43'
20.10°
3
SOBOBA ROAD
12
182.2'
18.42°
SAN JACINTO RIVER
23N2
177'
OLMSTED AVE.
RECLAMATION AREA
NEW YORK AVE.
13
60'
19.40°
23Q3
181'
BERGH ST.
220'-227'
17.20°
25D2
4
14'
26G2
198'
COOK ST.
7
ST.
PATH
105',
93',
102'
17.35°-17.60°
6
32'-35.3'
18.01°-18.65°
26J1
220'
LOS BANOS ST.
JORDAN AVE.
MONTROSE AVE.
BURT AVE.
5
128'

FIGURE 5. STATIC WATER LEVELS AND TEMPERATURES IN DRILLHOLES

rise in temperature in both holes below 200 feet suggest that other effects are operative here below the zone of influence of the river.

Two newly drilled observation holes 12 and 13 were also surveyed. Reliability of the results is questionable as there was still drilling mud in the holes. The water temperature in hole 12 is similar to that of hole 6, although the static water levels are different. In observation hole 13, the temperature is similar to that in holes 1 and 3, although hole 13 is within the channel of the San Jacinto River. In hole 12, there is a marked temperature increase in the segment between approximately 65 and 100 feet. This and the higher temperatures at about 25 feet may be due to influence from the spreading ponds. Similarly, in observation hole 13, the gradient is reversed below the water table, which is different from the gradients in observation holes 1 and 3. It is tentatively believed, therefore, that both observation holes 12 and 13 are within the zone of influence of the spreading operations although the case is not as strong for hole 12 (the anomaly is within the air column) as it is for hole 13.

RELATION TO WATER QUALITY

It is interesting to compare the results of the thermal survey with water quality data provided by EMWD. Reference is made to Figures 8 and 9 which present data for January and April 1970.

The spreading ponds area is characterized by high sulfate and high chloride concentration. Moreover, during several observations within the last three years, there has been 10% to 15% variation in both constituents. Much higher sulfate values are found east of the river in observation holes 1 and 3 but the corresponding chloride values are low. The continuation of high sulfate and low chloride values are also found in observation holes 6, 9, 10, and 25G1, whereas piezometers X-1 and Y-1 show high sulfate and high chloride values similar to those within the spreading area.

The remaining holes west of the river show low sulfate and low chloride values, which are probably representative of background conditions not significantly influenced by either the spreading area or the fault zone. The single exception is in well 23P5 which resembles the spreading ponds values in both sulfate and chloride. The reason for this is not known. It is unlikely due to migration from the spreading ponds, because well 23Q3 which intervenes,

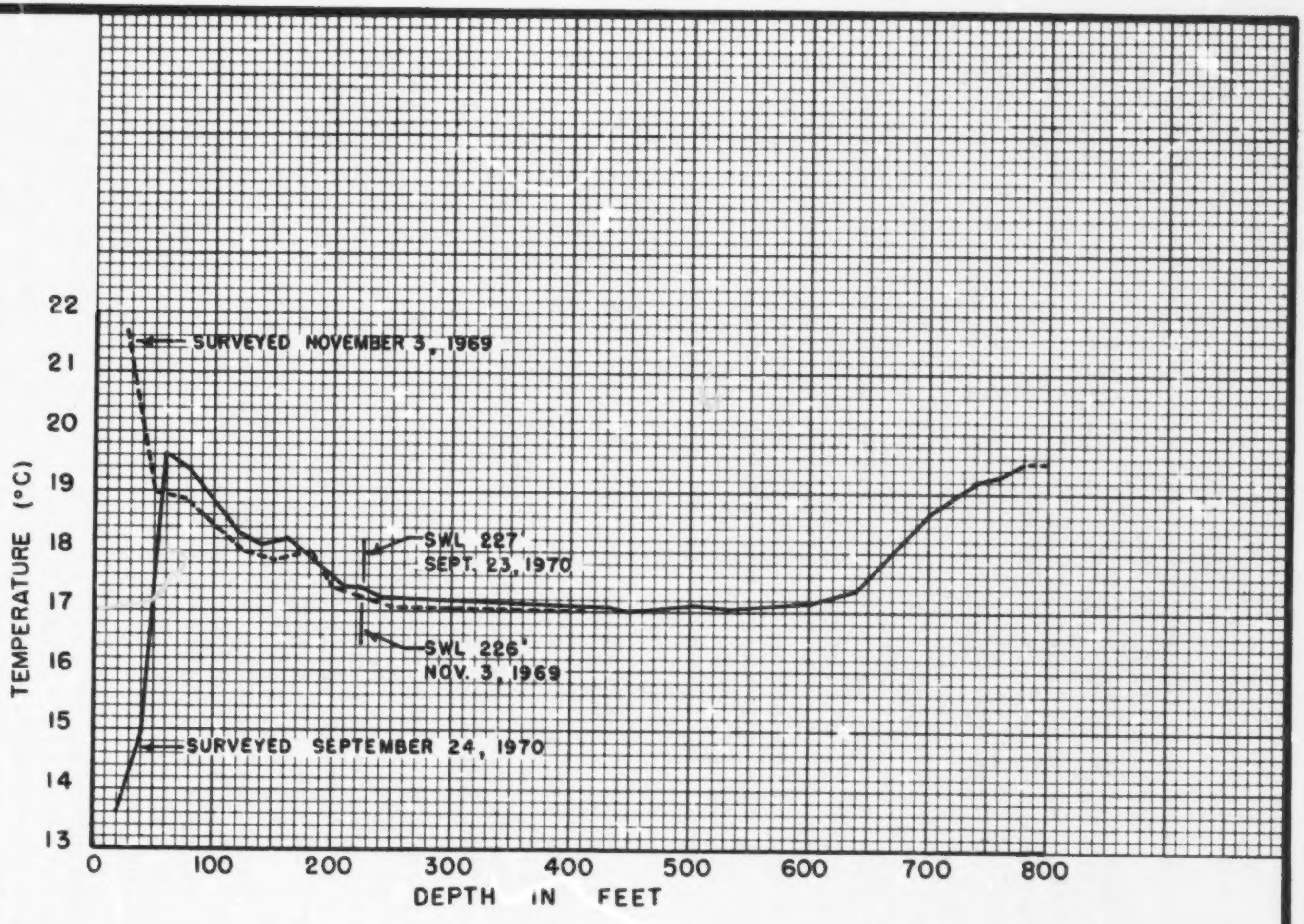


FIGURE 6. TEMPERATURE PROFILE OF WELL 25D2

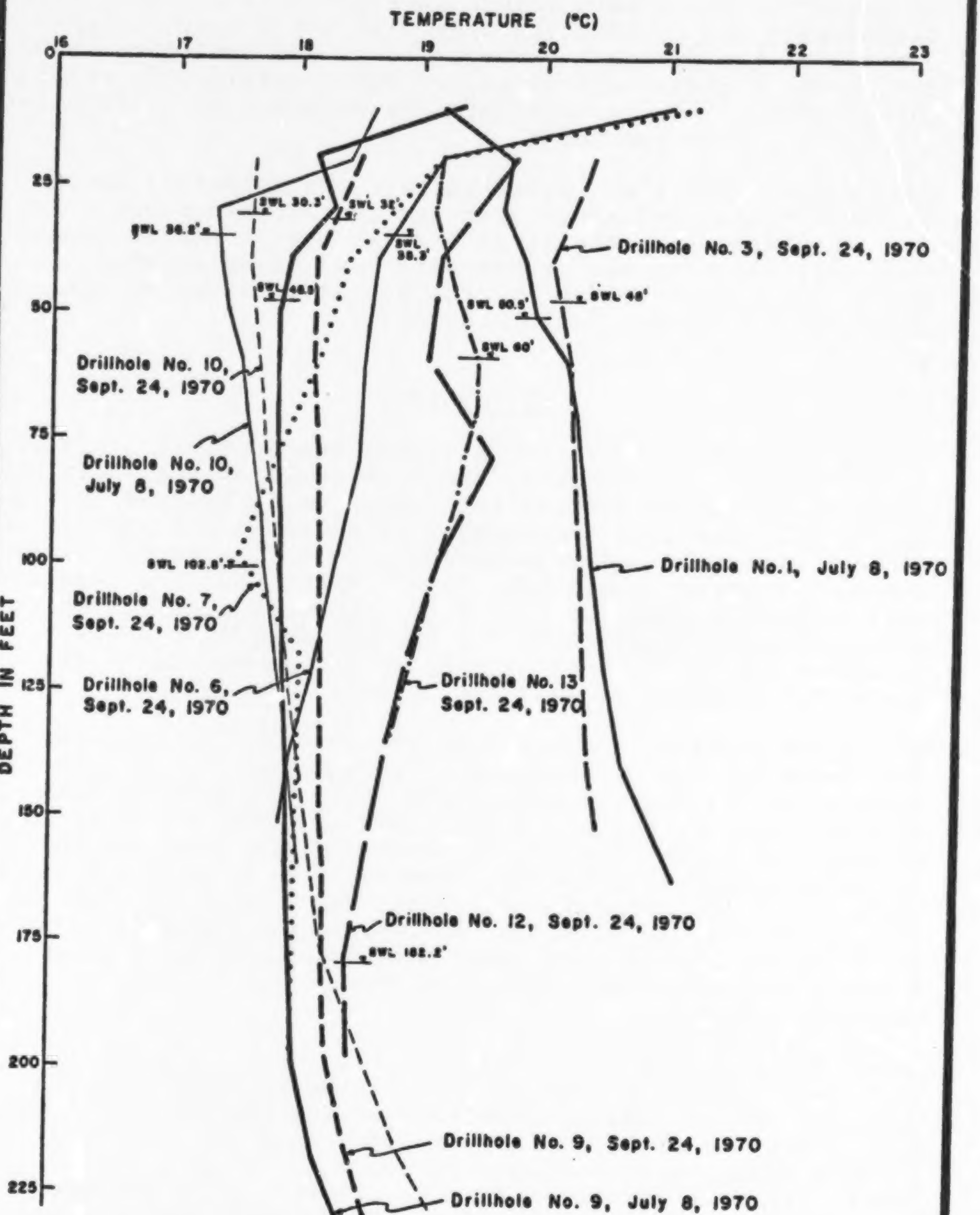


FIGURE 7. TEMPERATURE PROFILES OF DRILLHOLES

does not show comparable values.

With the exception of piezometer holes X-1 and Y-1, the distribution of sulfate values does not show obvious correlation with the reclamation area. As the average sulfate content of the effluent is reported as 130 ppm (1965-1969) and as the highest sulfate values occur outside the reclamation area, it would seem that the presence of sulfate is not derived from spreading.

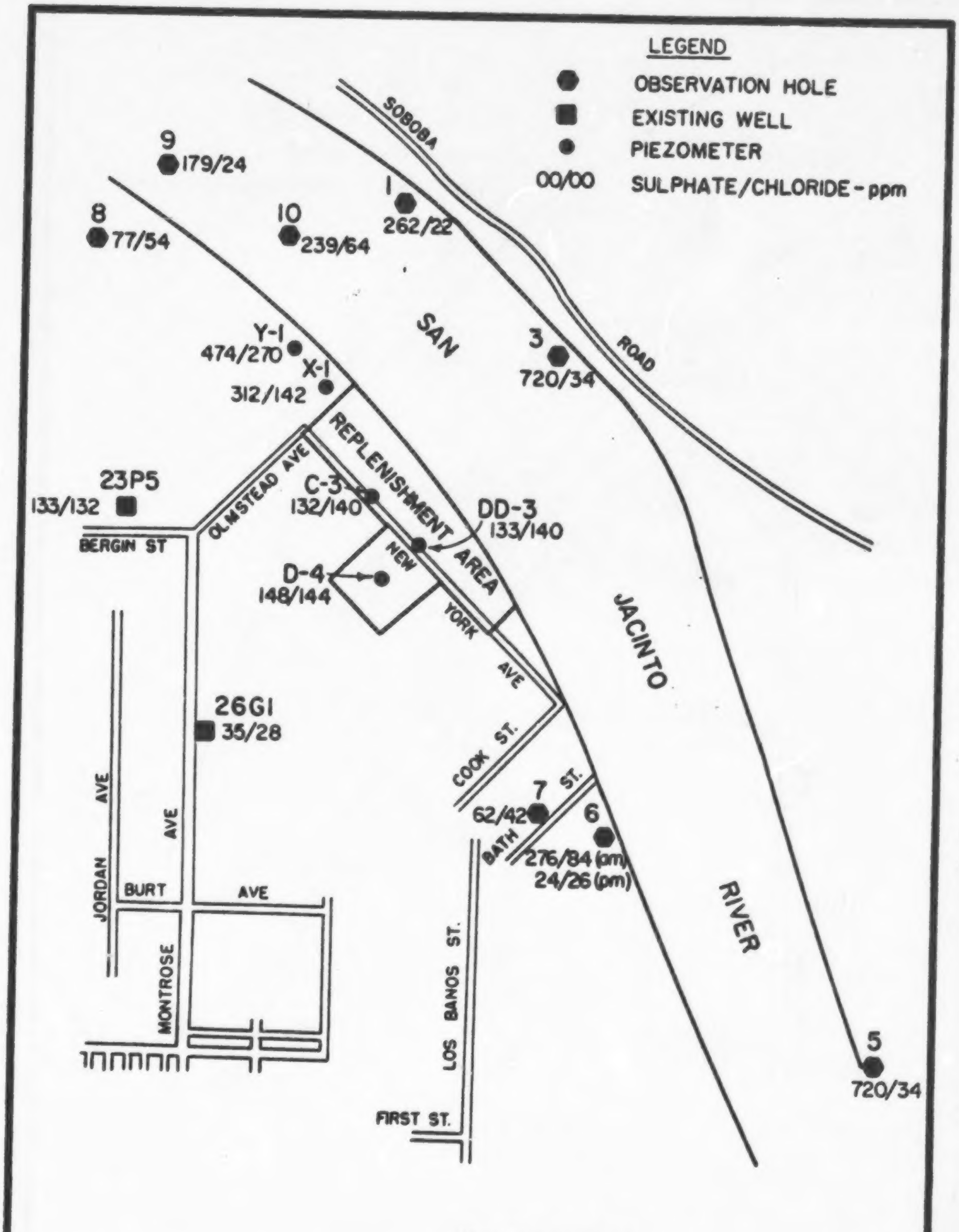
One obvious source of strong sulfate contamination would be hydrothermal solutions from the San Jacinto Fault. Perhaps solutions from the local hot springs or similar emanations are entering the ground water and being flushed northwestward (with some lateral migration also) by the underflow of the San Jacinto River.

CONCLUSIONS

From the ground temperature studies, the vertical profiles, and the water quality data, the zone of immediate influence seems to extend no farther than the area delineated in Figure 4. The vertical temperature profiles do not support a concept of simple and extensive downward flow to the water table. Moreover, the static water levels have declined in most instances where we have made repeat readings in observation holes. While there may be some migration downward to the water table, another explanation is needed to explain the disposal of most of the effluent.

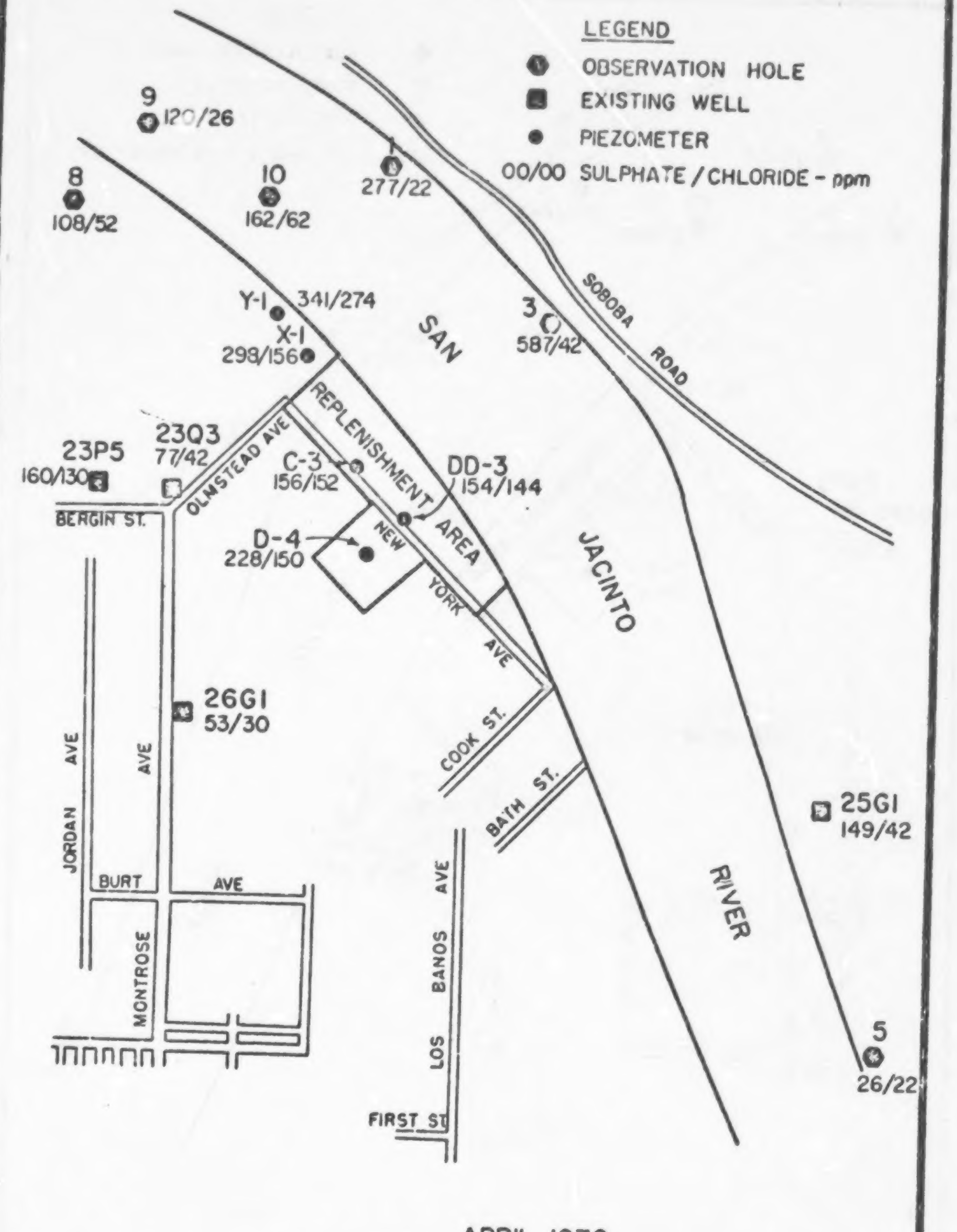
As stated earlier, the sediments beneath the survey area are characterized by abundant silt and clay layers interbeded with the coarser materials. Downward permeability is thus impeded, but horizontal permeability is likely to be high due to the flat-lying nature of the deposits and the likelihood of northwest-trending channel features associated with the present and earlier courses of the San Jacinto River. In addition, the northwest trending structures of the San Jacinto fault zone would probably impede transverse lateral migration and contribute to northwesterly control of fluid flow.

Given these geological conditions, it seems very likely that much or most of the effluent is being flushed northwesterly by the shallow underflow of the San Jacinto River. The process is probably very complex, with the detailed pattern changing in response to seasonal changes in the river. If this interpretation is correct, both the thermal and the chemical characteristics of the effluent will be diluted away from the spreading ponds, and the chemical anomaly should be traceable downstream.


LEGEND
⬢ OBSERVATION HOLE
■ EXISTING WELL
● PIEZOMETER
00/00 SULPHATE/CHLORIDE - ppm
SOBOBA ROAD
SAN JACINTO RIVER
9 179/24
8 77/54
10 239/64
1 262/22
3 720/34
Y-1 474/270
X-1 312/142
REPLENISHMENT AREA
23P5 133/132
C-3 132/140
DD-3 133/140
D-4 148/144
OLMSTEAD AVE
BERGIN ST
NEW YORK AVE
26G1 35/28
COOK ST.
7 62/42
BATH ST.
6 276/84 (pm) 24/26 (pm)
JORDAN AVE
MONTROSE AVE
BURT AVE
LOS BANOS ST.
FIRST ST.
5 720/34

JANUARY 1970

FIGURE 8. SULPHATE / CHLORIDE CONCENTRATIONS


LEGEND
OBSERVATION HOLE
EXISTING WELL
PIEZOMETER
00/00 SULPHATE / CHLORIDE - ppm
9
120/26
8
108/52
10
162/62
1
277/22
Y-1 341/274
X-1
298/156
3
587/42
SOBOBA ROAD
SAN JACINTO RIVER
23P5
160/130
23Q3
77/42
OLMSTEAD AVE
REPLENISHMENT AREA
C-3
156/152
DD-3
154/144
D-4
228/150
NEW YORK AVE
BERGIN ST.
26G1
53/30
COOK ST.
BATH ST.
JORDAN AVE
MONTROSE AVE
BURT AVE
LOS BANOS AVE
FIRST ST
25G1
149/42
5
26/22

APRIL 1970

FIGURE 9. SULPHATE / CHLORIDE CONCENTRATIONS

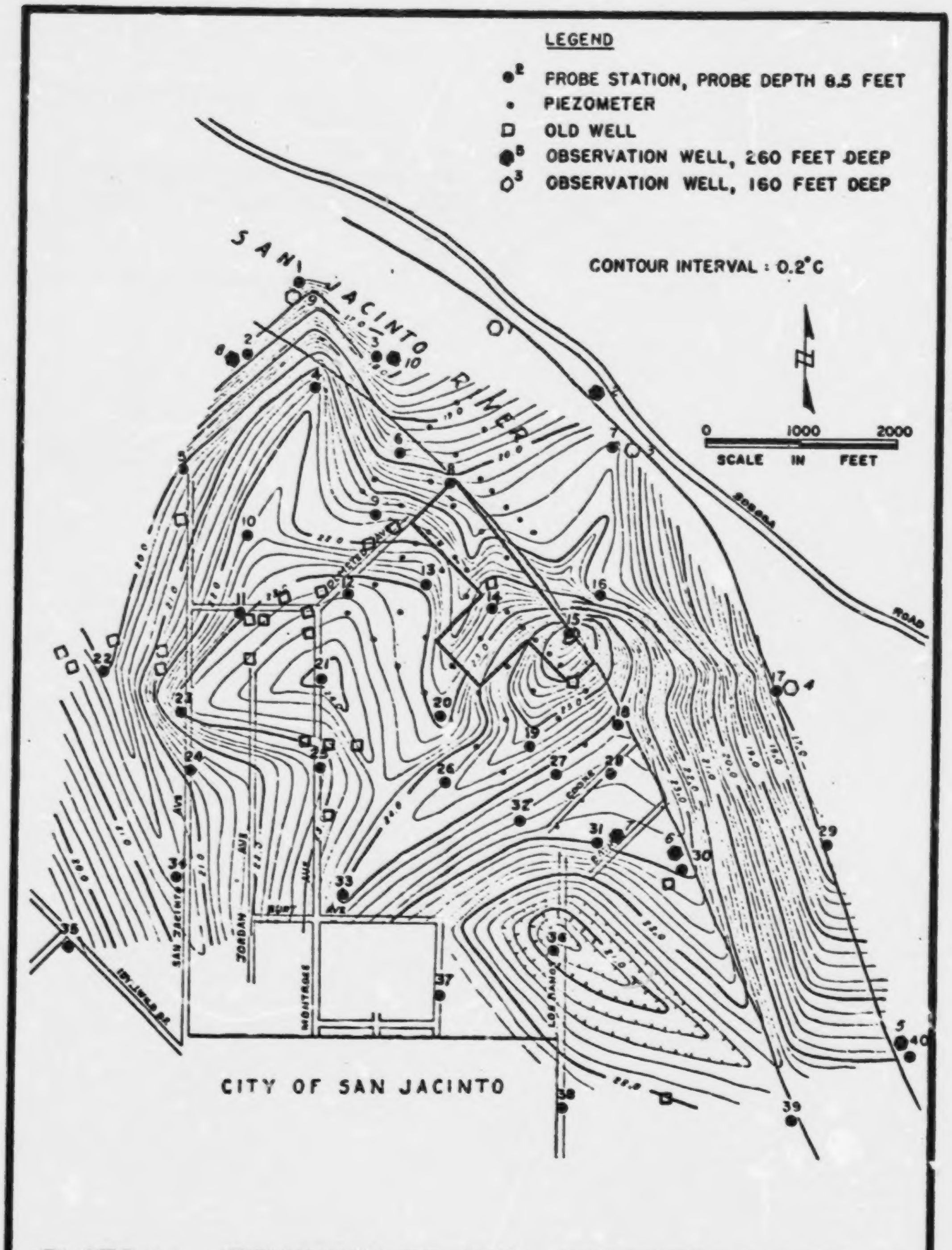

LEGEND
● FROBE STATION, PROBE DEPTH 8.5 FEET
• PIEZOMETER
□ OLD WELL
● OBSERVATION WELL, 260 FEET DEEP
○ OBSERVATION WELL, 160 FEET DEEP
CONTOUR INTERVAL : 0.2°C
N
0
1000
2000
SCALE IN FEET
SAN JACINTO RIVER
SOBOBA ROAD
SAN JACINTO AVE
JORDAN AVE
MONTROSE AVE
BURT AVE
CITY OF SAN JACINTO

PLATE I. TEMPERATURE MAP - SEPTEMBER 3, 1969

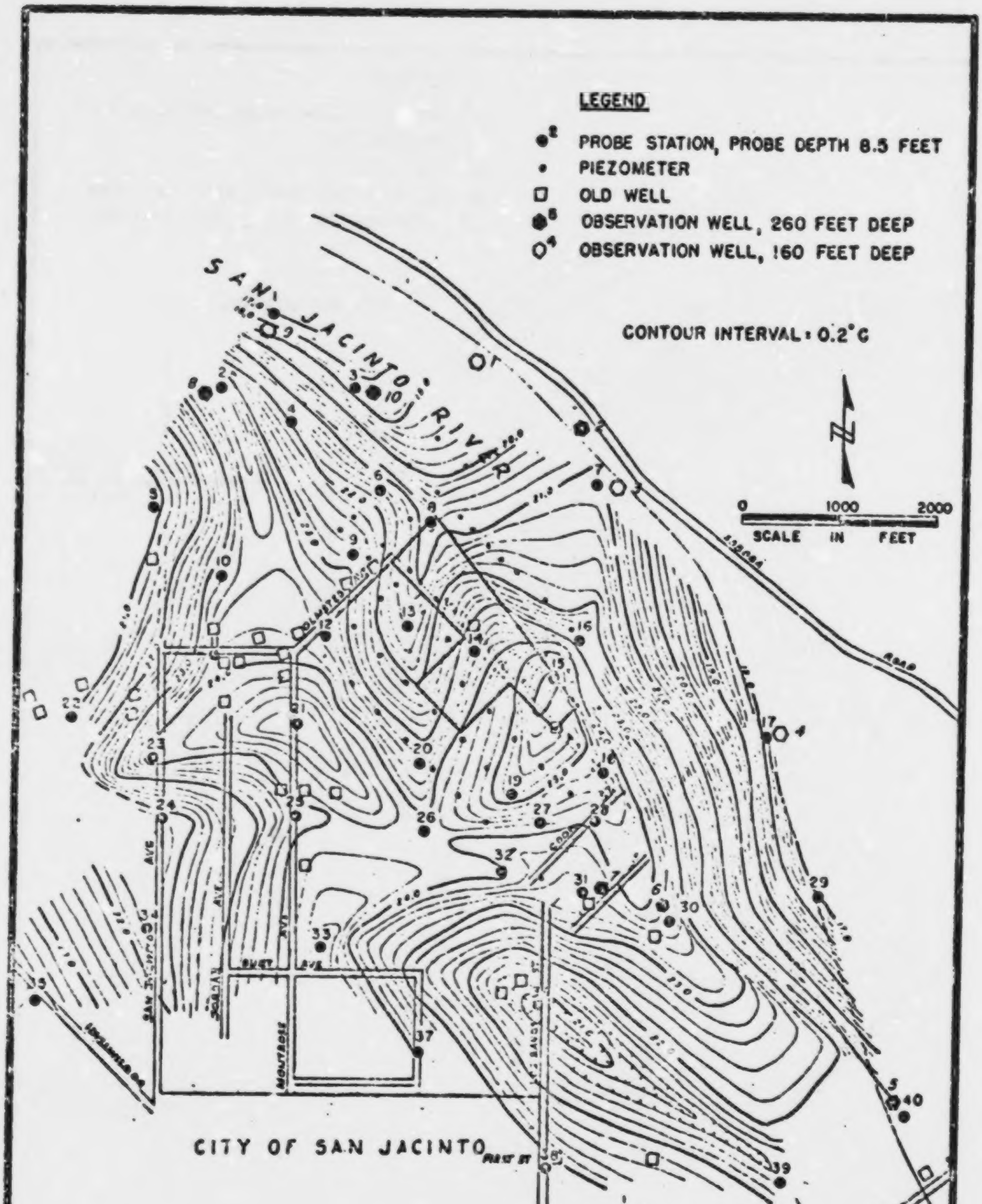

LEGEND
● PROBE STATION, PROBE DEPTH 8.5 FEET
• PIEZOMETER
□ OLD WELL
OBSERVATION WELL, 260 FEET DEEP
○ OBSERVATION WELL, 160 FEET DEEP
CONTOUR INTERVAL: 0.2°C
N
0 1000 2000
SCALE IN FEET
SAN JACINTO RIVER
CITY OF SAN JACINTO
SAN JACINTO AVE
MONTROSE
RUBY AVE
FIRST ST

PLATE 2. TEMPERATURE MAP - SEPTEMBER 19, 1969

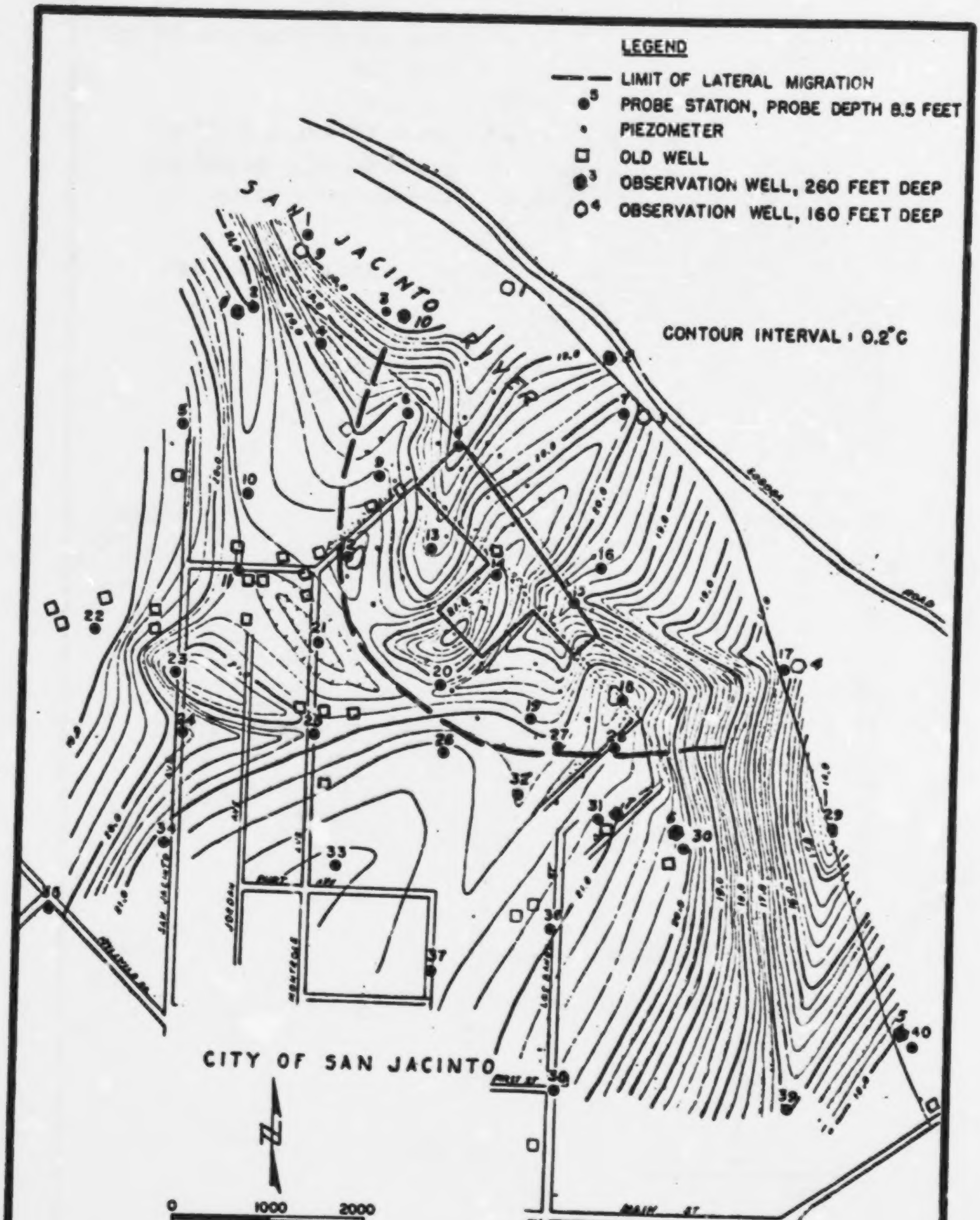

LEGEND
LIMIT OF LATERAL MIGRATION
PROBE STATION, PROBE DEPTH 8.5 FEET
PIEZOMETER
OLD WELL
OBSERVATION WELL, 260 FEET DEEP
OBSERVATION WELL, 160 FEET DEEP
CONTOUR INTERVAL : 0.2°C
SAN JACINTO RIVER
CITY OF SAN JACINTO
N
0
1000
2000
SCALE IN FEET
SOBOBA ROAD
MAIN ST
FIRST ST
SAN JACINTO
JORDAN
MONTEREE
LOS ANGELES
ESPLANADE AV.

PLATE 3. TEMPERATURE MAP - DECEMBER 16-17, 1969

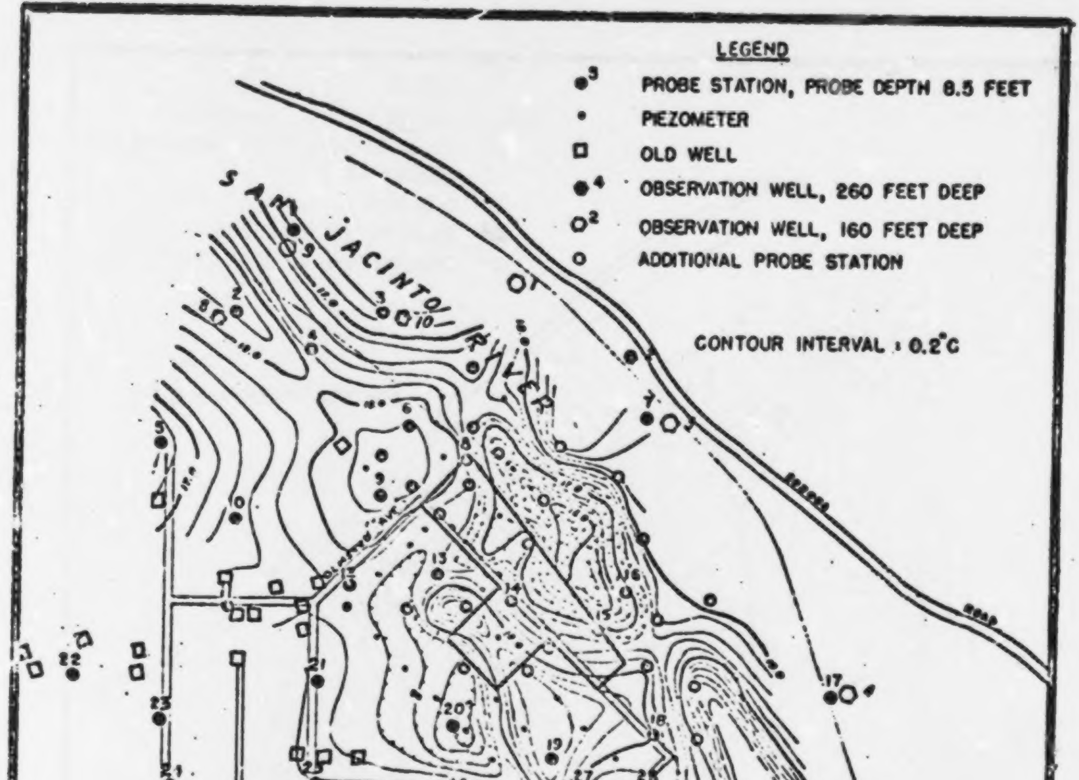

LEGEND
PROBE STATION, PROBE DEPTH 8.5 FEET
PIEZOMETER
OLD WELL
OBSERVATION WELL, 260 FEET DEEP
OBSERVATION WELL, 160 FEET DEEP
ADDITIONAL PROBE STATION
CONTOUR INTERVAL : 0.2°C
SAN JACINTO RIVER
CITY OF SAN JACINTO
SAN JACINTO AVE
JORDAN AVE
MONTROSE
LOS RANCHOS
MAIN ST
0
1000
2000
SCALE IN FEET
N

PLATE 4. TEMPERATURE MAP - MAY 6, 1970

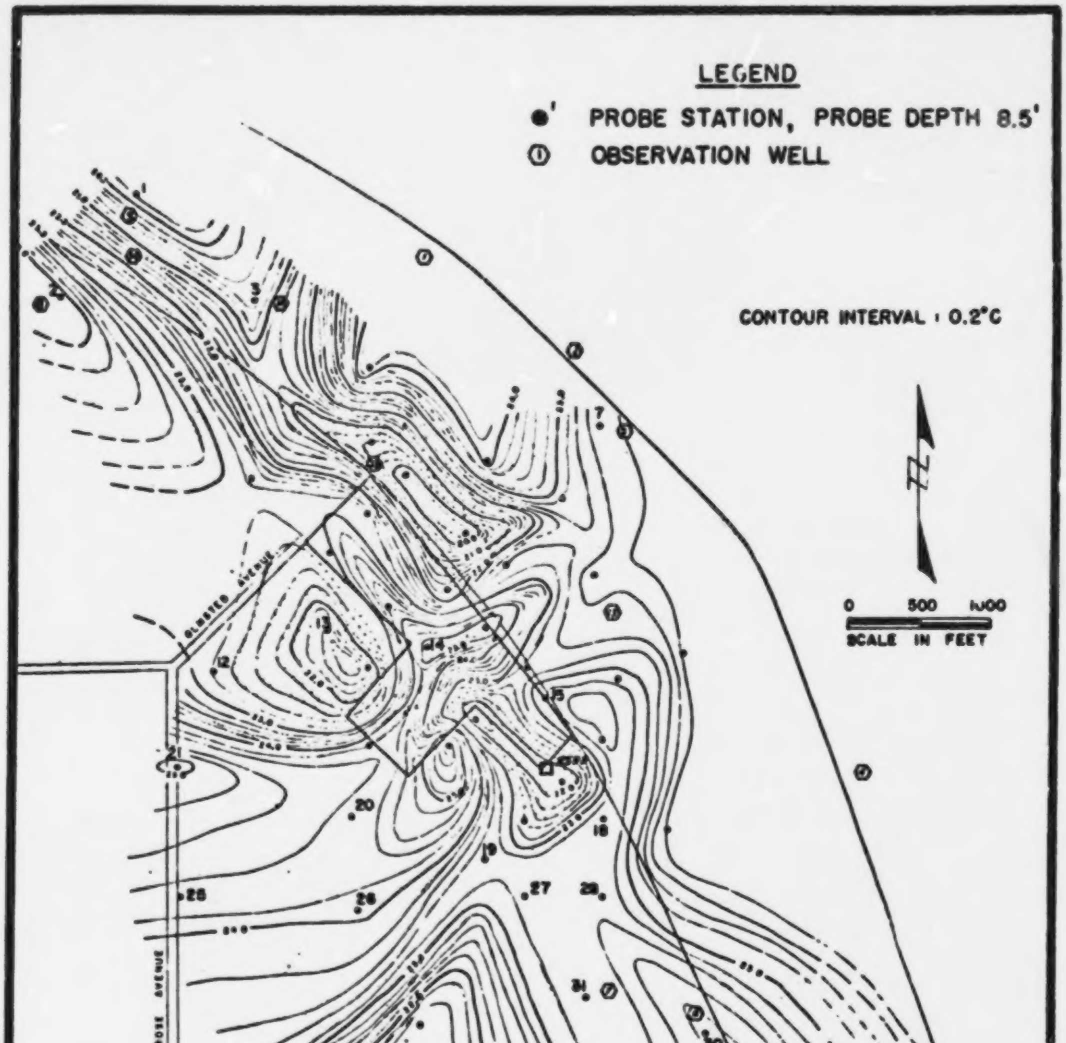

LEGEND
●' PROBE STATION, PROBE DEPTH 8.5'
① OBSERVATION WELL
CONTOUR INTERVAL : 0.2°C
N
0
500
1000
SCALE IN FEET
OLMSTED AVENUE
MONTROSE AVENUE
1
2
3
7
12
13
14
15
16
18
19
20
21
25
26
27
28
30
31
33

PLATE 5. TEMPERATURE MAP - SEPTEMBER 22-23, 1970

APPENDIX NO. 3

CHEMICAL QUALITY OF WATER FROM PIEZOMETERS

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CHEMICAL QUALITY OF WATER FROM PIEZOMETERS
(milligrams per liter)

Piezometer:	A-2	AA-3	BB-1	B-2	B-3		C-1	C-2			C2-2	C-3		
Date:	3/69	8/69	3/69	3/69	11/66	3/69	3/	12/	2/67	8/69	3/69	12/66	2/67	5/67
Analysis														
Calcium	-	62	-	-	73	-	-	520	519	53	-	84	79	76
Magnesium	-	10	-	-	6	-	-	[illegible]	[illegible]	11	-	22	21	20
Sodium	-	127	-	-	141	-	-	[illegible]	[illegible]	115	-	120	116	124
Potassium	-	10	-	-	14	-	-	10	[illegible]	10	-	6	3	4
Ammonia	trace	1	7.37	1.11	-	7.8	1.65	2	1.4	7	trace	0.1	0.1	0.1
Carbonate	-	17	-	-	46	-	-	0	0	0	-	0	5	0
Bicarbonate	-	200	-	-	46	-	-	207	143	248	-	244	198	220
Sulfate	-	-	-	-	200	-	-	1500	1535	75	-	150	144	140
Chloride	-	130	-	-	120	-	-	135	152	148	-	131	132	133
Nitrate	0	19	trace	0	41	5	2	6	8	0	0	48	44	40
Fluoride	-	1.72	-	-	0.5	-	-	0.2	0.3	1.75	-	1.3	1.0	0.8
Total Hardness as $CaCO_3$	364	194	600	754	208	173	542	1680	1676	176	370	300	280	276
T.D.S.	858	690	1145	1633	707	533	1128	2779	2596	652	960	765	706	700
Boron	-	0.40	-	-	0.47	-	-	0.4	0.06	0.60	-	0.6	0.55	0.6
MBAS	0	-	0	trace	-	trace	trace	0.3		0	0	0.2	-	0.3
C.O.D. Total	26.2	-	43.8	26.4	-	34.9	105	-		-	61.1	-	-	-
C.O.D.Dissolved	17.5	-	17.6	17.6	-	34.9	21.9	-		-	30.6	-	-	-
Total Nitrogen	0.20	-	11.17	1.90	-	81.3	2.32	-		-	0.42	-	-	-
pH	-	8.0	-	-	8.8	-	-	7.1	7.9	7.3	-	7.0	8.0	7.6
EC x 10^6	-	1020	-	-	1126	-	-	3600	7975	975	-	1120	1169	1100

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Piezometer:	C-C-3		D1-1	D-2	D-3a			D-4				D-5
Date:	5/67	2/69	3/69	2/69	12/66	2/67	2/69	11/66	5/67	2/69	8/69	2/67
Analysis												
Calcium	112	-	-	-	84	95	-	80	82	-	62	78
Magnesium	25	-	-	-	22	24	-	23	21	-	10	20
Sodium	161	-	-	-	132	140	-	139	120	-	127	115
Potassium	20	-	-	-	4	2	-	5	19		10	10
Ammonia	0.1	1.74	trace	0.90	0.6	0.5	0.71	-	0.9	0.99	6	0.3
Carbonate	0	-	-	-	0	10	-	4	0	-	0	2
Bicarbonate	262	-	-	-	287	315	-	242	259	-	194	166
Sulfate	276	-	-	-	150	167	-	220	163	-	147	146
Chloride	138	-	-	-	117	117	-	108	126	-	150	138
Nitrate	56	0	14	trace	47	44	2	24	35	trace	0	51
Fluoride	0.9	-	-	-	0.8	0.7	-	0.8	0.6	-	1.72	0.6
Total Hardness as $CaCO_3$	382	216	232	243	300	337	212	294	292	196	196	278
T.D.S.	977	3378*	653	3443*	728	773	3757*	726	681	2631*	678	738
Boron	0.60	-	-	-	0.8	0.56	-	0.27	0.52	-	0.57	0.54
MBAS	0.3	0	0	0	0.2	-	0	-	0.22	0	0	-
C.O.D. Total	-	82.7	35.0	82.7	-	-	39.4	-	-	55.2	-	-
C.O.D. Dissolved	-	39.4	30.6	39.4	-	-	35.4	-	-	39.4	-	-
Total Nitrogen	-	3.74	0.49	1.53	-	-	1.38	-	-	1.40	-	-
pH	7.9	-	-	-	7.7	8.1	-	8.2	7.6	-	7.2	8.2
EC x 10^6	1511	-	-	-	1100	1283	-	1207	1173	-	1020	1203

* Sulfuric Acid added to samples as preservative increased T.D.S.

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Piezometer:	D-D-3			E-1	E-3					E3-3	E-4		
Date :	5/67	2/69	8/69	3/69	11/66	12/66	2/67	2/69	8/69	2/69	11/66	2/69	8/69
Analysis													
Calcium	93	-	18	-	116	96	106	-	80	-	79	-	78
Magnesium	24	-	2	-	19	22	17	-	25	-	18	-	16
Sodium	131	-	63	-	136	128	138	-	115	-	133	-	115
Potassium	14	-	6	-	5	4	3	-	8	-	16	-	10
Ammonia	0.8	1.25	2	trace	0.3	0.3	0.3	1.4	Trace	Trace	-	1.46	Trace
Carbonate	14	-	4	-	0	0	0	-	0	-	0	-	0
Bicarbonate	298	-	50	-	378	287	342	-	303	-	224	-	209
Sulfate	137	-	-	-	150	160	160	-	120	-	123	-	172
Chloride	144	-	70	-	138	121	120	-	132	-	124	-	124
Nitrate	35	trace	4	51	44	48	35	6	0	2	78	0	trace
Fluoride	0.8	-	1.50	-	0.7	0.9	0.7	-	1.18	-	0.4	-	1.12
Total Hardness as $CaCO_3$	332	306	55	361	370	330	338	376	302		271	184	263
T.D.S.	731	1936*	275	818	851	843	780	1391*	725		736	1893*	701
Boron	0.50	-	0.28	-	0.6	0.8	0.8	-	0.54	-	0.7	-	0.47
MBAS	0.18	0	-	0	0.2	0.3	-	trace	0	-	-	trace	0
C.O.D. Total	-	71.0	-	26.2	-	-	-	61.8	-	44.2	-	22.2	-
C.O.D. Dissolved	-	53.3	-	21.9	-	-	-	39.7	-	26.5	-	22.2	-
Total Nitrogen	-	1.49	-	0.30	-	-	-	1.57	-	-	-	1.38	-
pH	8.1	-	7.2		7.8	8.0	8.2	-	7.3	-	8.1	-	7.4
EC x 10^6	1274	-	415		1260	1240	1333	-	1105	-	1166	-	1069

* Sulfuric Acid added to samples as preservative increased T.D.S.

Piezometer:	E-5		F-3	F-4		G-3	G-5	Effluent Average
Date:	12/66	2/69	2/69	2/69	8/69	2/69	2/69	1965-1969
Analysis								
Calcium	85	-	-	-	77	-	-	63
Magnesium	19	-	-	-	14	-	-	12
Sodium	116	-	-	-	127	-	-	125
Potassium	5	-	-	-	10	-	-	18
Ammonia	0	3.04	2.79	4.25	2	0.86	trace	15
Carbonate	7	-	-	-	0	-	-	0
Bicarbonate	274	-	-	-	264	-	-	250
Sulfate	137	-	-	-	117	-	-	130
Chloride	113	-	-	-	140	-	-	117
Nitrate	23	trace	27	4	0	50	9	27
Fluoride	0.6	-	-	-	1.80	-	-	0.9
Total Hardness as $CaCO_3$	290	247		247	251	302		208
T.D.S.	677	2004*		2122*	729	2059*		686
Boron	0.6	-	-	-	0.60	-	-	0.7
MBAS	-	0	-	trace	0	0	-	1.34
C.O.D. Total	-	26.5	75.0	35.3	-	17.6	348	
C.O.D. Dissolved	-	22.1	70.5	30.8	-	8.8	61.8	
Total Nitrogen	-	3.19	-	5.7	-	4.12		
pH	8.2	-	-	-	7.5	-		7.1
EC x 10^6	1165	-	-	-	1105	-		1130

* Sulfuric Acid added to samples as preservative increased T.D.S.

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APPENDIX NO. 4

WELL DATA

Wells in the Upper San Jacinto Groundwater Basin are identified utilizing the numbering system used by the California State Department of Water Resources, according to township, range and section. (All of the wells are referenced to the San Bernardino Base and Meridian as the points of origin) Under this system each section is divided into 40-acre parcels which are lettered as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Wells are numbered within each of the 40-acre parcels according to the order in which they are located. For example, the well having the number 4S/1W - 25G1 would be found in Township 4 South, Range 1 West and in Section 25 San Bernardino Base and Meridian. It is further identified as the first well located in the 40-acre parcel lettered G, which is the southwest quarter of the northeast quarter of Section 25.

Locations of the wells listed in this appendix are depicted on Figures 13 and 46, entitled "Well Location Map", which are found in Volume 1 of this report.

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Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 23K2	Gerald Halman	---	315	14"	40 H.P. Electric	Not Used	Static Level Analysis	---	910' NW C/L Olmstead & 220' SW C/L New York & 1170' NE Montrose
23L1	Don Baker, Jr.	---	---	--	---	Dom.	Static Level	---	2050' NW/O Inter. at Alessandro Ave., Bergin St. & Olmstead St. Along Dirt Road 250' NE/O Dirt Road in Back of Residence
23N2	Wm. Plantinga	---	315	12"	50 H.P. Electric	Irrig.	Static Level Analysis	---	900' N/O Bergin & 110' W/O San Jacinto (ext.)
23P1	H.L. Pastorious	8/8/48	458	12"	3 H.P. Sub. Electric	Dom. & Irrig.	Static Level Analysis	Driller - L. Van Winkle	1200' NW/O Inter. of Montrose, Olmstead & Bergin & 450' NE/O Montrose
23P2	H.L. Pastorious	---	118	5"	None	Not Used	Static Level	---	75' NE/O Montrose & 1200' NW/O Inter. of Bergin & Montrose
23P3	H.L. Pastorious	---	---	10"	Sub. Electric	Dom. & Irrig.	Analysis	No Access	200' NE/O Montrose & 1250' NW/O Bergin & Montrose
23P4	Wm. Plantinga	---	296	--	15 H.P. Electric	Dom. & Dairy	Static Level Analysis	---	220' N/O Bergin & 400' E/O San Jacinto
23P5	Ferchaud	---	---	4"	1/2 H.P. Electric	Dom.	Static Level Analysis	Driller - Livesay	45' N/O Bergin & 465' W/O Montrose - 10' W/O Well 23P6

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 23P7	D.M. Olsthoorn	---	80	10"	None	Not Used	Static Level Analysis	---	670' NW/O Inter. of Bergin & Olmstead & 120' NE/O C/L Dirt Road Behind Unoccupied House
23Q3	D.M. Olsthoorn	---	---	8"	15 H.P. Electric	Dom. & Stock	Static Level Analysis	Cascading water	90' NW/O Olmstead & 260' N/O Bergin
23Q4	Gerard Halman	---	---	--	3 H.P. Electric	Stock	Static Level	---	150' NW/O Olmstead & 190' SW/O Inter. of New York & Olmstead
23Q6	Mero, Clifford	---	---	6"	3/4 H.P. Electric	Dom.	Static Level Analysis	---	160' NW/O C/L Olmstead & 860' NE/O Inter. of Olmstead & Bergin
23R1	EMWD	---	473	12"	None	Observ.	Static Level Analysis		950' SE/O Olmstead & 40' NE/O New York
4S/1W 25D2	EMWD	1/66	830	12"	None	Observ.	Static Level Analysis E-Log	(Sounded 780') Drilled by R&W	2725' E/O Alessandro & 630' S/O Bergin Extended East
25E1	J.H. Schroeder	Prior to 1936	238	12"	None	Not Used	Static Level	Destroyed 1969	2640' N. & 450' E/O SW Corner of Sec. 25

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 25G1	EMWD	10/59	620	14"	75 H.P. Electric	Dom. & Munic.	Static Level Analysis	Drilled by L.O. Lynch	300' E/O River Channel & 4420' NE/O Main & Soboba Rd. & 2340' NW/O Soboba Rd.
25M1	San Jacinto Spice Farms	---	518	8"	100 H.P. Elect.	Irrig.	Static Level Analysis	---	2750' NE/O First & Camino Los Banos & 3930' NW/O Main & Mountain
25N1	San Jacinto Spice Farms	7/48	475	--	100 H.P. Electric	Irrig.	Static Level Analysis Well Log	Drilled by L. Van Winkle	50' N/O First St. (ext.) & 1125' E/O Camino Los Banos
25N2	San Jacinto Spice Farms	4/68	622	--	100 H.P. Electric	Irrig.	Static Level Well Log	Drilled by L.O. Lynch	135' E/O C/L Camino Los Banos & ? N/O C/L First St.
25Q1	---	6/58	528	--	30 H.P. Sub. Electric	Irrig.	Analysis	Drilled by L.O. Lynch	1000' N. & 1500' W/O Sec. Cor. 25
4S/1W 26C1	R.D. Wilson	1950	276	10"	5 H.P. Electric	Dom., Irrig., Stock	Static Level Analysis	---	620' E/O San Jacinto Ave. & 570' S/O Bergin & 700' W/O Montrose
26C2	Whitehurst	---	204	8"	None	Not Used	Static Level	---	50' W/O Montrose & 350' S/O Bergin St.
26C3	Whitehurst	---	100	8"	1 H.P. Electric	Dom.	Static Level Analysis	---	50' S/O C/L Bergin St. & 60' W/O C/L Montrose
26C4	Don Norman	1967	312	8"	Electric	Dom.	Static Level Analysis	Drilled by L.O. Lynch	250' S/O C/L Bergin St. & 600' W/O C/L Montrose

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 26C6	Don Norman	---	---	8"	None	Not Used	Static Level	---	255' S/O C/L Bergin St. & 635' W/O C/L Montrose St.
26D3	Katz & Assoc.	---	165	12"	None	Not Used	Static Level	---	345' W/O San Jacinto Ave. & 810' S/O Bergin St.
26D4	William Howe	1964	167	6"	3/4" H.P. Sub. Electric	Dom.	Static Level Analysis	Drilled by W. Clark	1250' W/O San Jacinto Ave. & 230' S/O Sunset Lane (inside of Wishing Well)
26D5	E. V. Robson	---	68	4"	1 H.P. Electric	Dom.	Static Level Analysis	Sounded Depth 61-1	900' W/O San Jacinto Ave. & 70' N/O Sunset Lane on South Side of Garage
26D6	Helper	---	---	4"	1/4 H.P. Electric	Dom.	No Entry	Active	350' W/O San Jacinto Ave. & 100' S/O Sunset Lane
26D9	Helper	---	93	8"	None	Not Used	Static Level	---	380' W/O San Jacinto Ave. & 270' S/O Sunset Lane
26D11	William Howe	---	68	5"	None	Not Used	Static Level	---	1315' W/O San Jacinto Ave. & 216' S/O Sunset Lane
26E3	---	1949	---	12"	None	Not Used	Static Level	---	230' W/O San Jacinto Ave. & 1490' S/O Bergin St.
26F1	Pete Halman	7/15/59	310	12"	30 H.P. Electric	Dom. & Dairy	Pumping Levels Well Log Analysis	---	1 mi. N/O Main St. & 144' W/O Montrose Ave.

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 26G1	Gerard Halman	3/56	300	12"	25 H.P. Electric	Dom. & Dairy	Static Level Well Log Analysis	Drilled by L. Van Winkle	150' E/O Montrose & 1550' N/O Burt St.
26G2	Gerard Halman	2/29/56	300	12"	30 H.P. Electric	Irrig.	Static Level Analysis	---	1700' N/O Burt St., 675' E/O Montrose & 1600' S/O Bergin
26G3	N. Krynen	1960	311	8"	Sub. Electric	Dom. & Dairy	Static Level Analysis	Now Abandoned	800' N/O Burt St. & 150' E/O Montrose
26J1	Hoffman, et al	10/51	483	14"	Portable Diesel	Irrig.	Static Level Analysis	Drilled by L. Van Winkle	400' W/O Bath St. & 2640' N/O Main St.
26J2	Hoffman, et al	1954	---	14"	None	Not Used	Static Level Analysis	Sanded in Casing Collapsed at 220'	510' W/O Camino Los Banos & 1350' N/O First St.
26L1	Geo. W. Wright	---	100	7"	1/2 H.P. Electric	Dom.	No Entry Analysis	---	400' E. C/L San Jacinto Ave. & 1720' N. Inter. Idyllwild Dr. & San Jacinto Ave.
26L3	Adolf Pirot	---	250	12"	20 H.P. Electric	Irrig.	Static Level Analysis	---	520' E. C/L San Jacinto Ave. & 1410' N. C/L First St.

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 26M2	D. Eastham	1936	496	14"	None	MWD Observ.	Static Level	---	30' W/O San Jacinto Ave. & 2950' S/O Bergin St.
26Q1	Clifford Rose	7/25/60	280	8"	None	Not Used	Static Level Well Log	---	290' N. C/L First St. & 90' W. C/L Vernon St. Extended North
26R1	John Etchart	---	---	4"	None	Not Used	Static Level Analysis	---	450' W/O Bath St. & 860' N/O First St., Southerly of 3 Wells
4S/1W 35A4	City of San Jacinto	7/56	660	14"	150 H.P. Electric	Munic.	Analysis	Drilled by L. Van Winkle	380' W. C/L Bath St. & 780' N. C/L Main St.
35G1	City of San Jacinto	6/59	512	14"	75 H.P. Electric	Munic.	Analysis	Drilled by L. O. Lynch	65' E/O Mistletoe Ave. & 190' S/O Main St.
4S/1W 36A1	Soboba Country Club	8/10/61	835	14"	Natural Gas	Irrig.	Static Level Well Log Analysis	Drilled by L. O. Lynch	100' NW/O Main St. & 2200' SW/O Soboba Rd.
36A2	---	---	---	12"	None	Not in Use	Static Level Analysis	---	1900' SW/O Soboba Rd. & 400' SE/O Main St.

Well No.	Owner	Date Drilled	Well Depth	Casing	Pumping Equip.	Use	Other Data	Remarks	Location
4S/1W 36C1	---	---	---	--	None	Not Used	None	Caved In	50' N/O Main St. & 300' W/O Main St. & Mountain Ave.
36D1	Bob Hoffman	11/16/60	404	10"	Electric	Not Used	Static Level Well Log	Drilled by L. O. Lynch	279' E. C/L Camino Los Banos & 224' N. C/L Main St.
36E2	San Jacinto Spice Farm	1952	295	--	---	---	Analysis	Well Deepened to 295'	450' S/O Main St. & 0.25 mi. E/O Camino Los Banos

APPENDIX NO. 5

CHEMICAL QUALITY OF GROUNDWATER FROM WELLS

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Wells in the Upper San Jacinto Groundwater Basin are identified utilizing the numbering system used by the California State Department of Water Resources, according to township, range and section. (All of the wells are referenced to the San Bernardino Base and Meridian as the points of origin) Under this system each section is divided into 40-acre parcels which are lettered as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Wells are numbered within each of the 40-acre parcels according to the order in which they are located. For example, the well having the number 4S/1W - 25G1 would be found in Township 4 South, Range 1 West and in Section 25 San Bernardino Base and Meridian. It is further identified as the first well located in the 40-acre parcel lettered G, which is the southwest quarter of the northeast quarter of Section 25.

Locations of the wells listed in this appendix are depicted on Figures 13 and 46, entitled "Well Location Map", which are found in Volume 1 of this report.

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State Well No.	Date Sampled	ECx10^6 at 25°C	pH	Parts per Million Milligrams Equivalents per Liter Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Percent Na
4S/1W23K2	5 -20-65	963	7.5	140 7.00	24 2.00	26 1.13	5 0.13	0 ---	397 6.50	88 1.83	53 1.50	0 ---	0.1	---	624	450	11
4S/1W23N2	9 -22-65	310	7.7	38 1.92	4 0.32	22 0.96	1 0.03	0 ---	174 2.85	6 0.13	12 0.35	0 ---	0.3	0.1	206	112	30
	1 -20-67	415	7.8	50 2.48	7 0.56	26 1.13	3 0.08	0 ---	189 3.10	20 0.42	23 0.65	2 0.03	0.2	0.1	257	152	27
	11-21-68	400	7.5	36 1.80	10 0.78	14 0.60	2 0.05	--- ---	144 2.36	8 0.17	19 0.54	5 0.08	.33 0.02	Tr.	244	129	-
	6 -19-69	386	7.4	42 2.10	6 0.56	16 0.70	2 0.05	4 0.02	142 2.32	9 0.19	26 0.76	Tr. Tr.	0.27 0.01	Tr.	234	133	-
4S/1W23P3	11-25-68	675	7.4	69 3.45	22 1.77	18 .80	4 .09	- -	232 3.80	50 1.04	40 1.13	3 0.05	0.27 0.01	Tr.	447	260	-
	6 -25-69	680	7.6	78 3.90	17 1.42	23 1.00	3 0.08	0 0	211 3.45	64 1.33	50 1.41	4 0.06	0.57 0.03	0	472	266	
	1 -19-70	515	7.2	60 3.00	9 0.70	25 1.10	4 0.10	0 0	162 2.66	32 0.67	54 1.52	Tr.	0.44 0.02	Tr.	350	185	
4S/1W23P4	9 -22-65	370	7.7	48 2.40	6 0.48	26 1.13	2 0.05	0 ---	177 2.90	33 0.69	16 0.45	0 ---	0.4	0.1	255	144	28
	11-25-68	400	7.6	47 2.34	6 0.48	11 .50	2 0.05	--- ---	150 2.46	17 0.35	20 0.58	2 0.03	0.55 0.03	Tr.	263	141	
	6 -25-69	480	7.4	51 2.55	9 0.74	25 1.10	3 0.08	0 0	157 2.57	42 0.87	32 0.90	1 0.02	0.57 0.03	0	338	165	
	11- 5-70	490	8.0	66 3.28	2 0.16	34 1.48	5 0.13	0 ---	195 3.20	42 0.88	28 0.80	2 0.03	0.2	0.1	310	172	29
4S/1W23P5	12- 2-68	1050	7.1	119 5.95	15 1.27	67 1.92	14 0.35	--- ---	191 3.14	131 2.73	120 3.39	5 0.08	0.17 0.01	Tr.	650	361	
	5 - 2-69	1100	7.2	118 5.90	24 1.94	53 2.30	10 0.25	0 0	217 3.56	140 2.92	128 3.62	0 0	0.23 0.01	0.12	684	392	
	1 -21-70	1080	7.4	118 5.90	24 1.94	55 2.40	4 0.10	0 0	230 3.76	133 2.76	132 2.76	0 0	0.36 0.02	0.82	702	400	

State Well No.	Date Sampled	$EC \times 10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter									F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Per-cent Na
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3					
4S/1W23Q4	5 -20-65	264	8.7	18 0.92	2 0.20	36 1.57	5 0.13	30 1.00	85 1.40	2 0.04	18 0.50	0 ---	0.5	---	168	56	56
	11- 1-66	350	7.6	27 1.36	5 0.44	37 1.61	4 0.10	0 ---	159 2.60	19 0.40	25 0.70	0 ---	0.4	0.3	225	90	46
	4 -18-67	385	7.2	45 2.26	9 0.70	34 1.48	4 0.10	0 0	184 3.02	39 0.82	28 0.78	0.4 0.01	---	0.37	296	148	---
	11-18-68	575	7.55	50 2.50	17 1.38	26 1.15	6 0.15	---	161 2.64	93 1.93	22 0.62	4 0.06	0.45 0.02	Tr.	325	194	---
	6 -19-69	545	7.6	76 3.80	9 0.74	18 0.80	2 0.05	0 0	172 2.82	84 1.75	24 0.68	3 0.05	0.55 0.03	Tr.	380	228	---
	11- 5-70	430	7.8	46 2.32	7 0.56	34 1.48	8 0.21	0 ---	186 3.05	36 0.75	23 0.65	1 0.02	0.3	0.1	257	144	32
4S/1W23Q6	1 - 2-69	1205	7.7	112 5.60	20 1.65	82 3.55	10 0.25	--- ---	262 4.29	170 3.54	117 3.30	5 0.08	0.75 0.04	0.36	795	372	---
	5 -13-69	1160	7.2	116 5.80	24 1.96	77 3.35	10 0.25	0 0	264 4.32	159 3.30	122 3.44	2 0.03	0.46 0.02	0.35	793	388	---
	7 -24-69	1210	7.1	128 6.40	19 1.60	100 4.35	5 0.13	0 ---	317 5.20	180 3.75	122 3.45	2 0.03	---	---	745	400	---
	1 -21-70	1200	7.2	115 5.75	21 1.70	98 4.25	8 0.20	0 0	290 4.75	151 3.14	134 3.78	Tr.	0.43 0.02	1.04	828	380	---
	11- 5-70	1140	8.1	128 6.40	17 1.40	93 4.04	8 0.21	12 0.40	296 4.85	135 2.81	126 3.55	3 0.05	0.1	0.1	709	390	34
4S/1W23R1	5 -26-70	327	7.9	38 1.91	4.5 0.37	23 0.99	3.9 0.10	0 0	178 2.92	1.4 0.03	13 0.36	4.9 0.08	0.3 0.02	0.05	188	114	
	12-14-66	340	7.8	40 2.00	5 0.44	26 1.14	2 0.06	--- ---	190 3.12	1 0.01	11 0.31	0.5 0.01	0.2 0.01	0.2	194	122	
	4 -18-67	290	8.2	18 0.90	4 0.32	35 1.54	5 0.14	2 0.08	139 2.28	4 0.08	17 0.48	0.7 0.01	0.3 0.02	0.50	152	61	

State Well No.	Date Sampled	$EC \times 10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Percent Na
4S/1W23R1	7 - 3-67	298	7.4	31 1.57	4 0.35	24 1.06	3 0.07	--- ---	161 264	2 0.04	11 0.32	4 0.06	0.3 0.02	0.10	134	96	---
	11-18-68	400	7.6	20 1.00	3 0.26	23 1.00	5 0.13	--- ---	110 1.81	5 0.10	18 0.51	4 0.06	0.38 0.02	Tr.	155	63	---
	8 -14-69	420	7.4	45 2.25	4 0.[illegible]5	23 1.00	4 0.10	0 0	161 2.66	2 0.04	26 0.73	0 0	0.43 0.02	0	272	129	---
4S/1W25D2	5 -26-66	436	8.0	49 2.44	5.8 0.48	30 1.29	3.1 0.08	0 0	206 3.38	12 0.26	20+ 0.58	4.0 0.06	0.5 0.03	0.03	262	146	---
	12-14-66	414	7.7	46 2.32	7 0.54	33 1.43	3 0.07	--- ---	201 3.30	20 0.42	19 0.53	0.9 0.01	0.3 0.02	0.12	245	143	---
	4 -18-67	451	7.8	48 2.41	7 0.61	33 1.44	5 0.13	0 0	196 3.22	30 0.62	21 0.58	2.9 0.05	0.4 0.02	0.71	260	151	---
	5 -17-67	452	8.0	50 2.47	7 0.57	34 1.47	4 0.09	--- ---	195 3.20	35 0.73	23 0.73	6.2 0.10	0.6 0.03	0.48	209	152	---
	7 - 3-67	404	7.3	45 2.24	8 0.62	30 1.31	3 0.07	--- ---	198 3.24	15 0.32	17 0.49	5 0.08	0.4 0.02	0.14	223	143	---
	11-25-68	405	7.95	44 2.20	2 0.16	23 1.00	3 0.07	--- ---	136 2.23	4 0.08	19 0.54	5 0.08	0.27 0.01	0	262	118	---
4S/1W25G1	8 - 8-61	526	7.4	58 2.90	4 0.33	42 1.83	2 0.05	0 ---	235 3.85	25 0.52	28 0.80	0 ---	---	---	---	160	36
	3 -27-63	576	8.2	61 3.04	9 0.76	40 1.74	2 0.05	6 0.20	241 3.95	40 0.83	27 0.75	0 ---	0.6 ---	---	370	190	31
	9 - 4-65	540	8.0	64 3.20	8 0.64	46 2.00	2 0.05	0 ---	244 4.00	33 0.69	30 0.85	6 0.10	0.9 ---	0.2	370	192	34
	3 - 6-66	720	7.8	72 3.60	10 0.80	53 2.30	4 0.10	0 ---	232 3.80	96 2.00	32 0.90	1 0.02	0.4 ---	0.3	430	220	34

				Parts per Million Milligrams Equivalents per Liter													
State Well No.	Date Sampled	ECx10^6 at 25°C	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Per-cent Na
4S/1W25G1	6 -28-68	720	7.2	69	13 1.12	52 2.26	5 0.13	0 ---	217 3.55	105 2.19	43 1.20	1 0.02	0.5	0.1	461	228	33
	11-25-68	725	7.45	66 3.30	18 1.45	43 1.85	6 0.15	--- ---	189 3.10	106 2.21	46 1.30	2 0.03	0.39 0.02	0.17	502	237	---
	11- 5-70	670	8.1	72 3.60	14 1.20	58 2.52	[illegible] 0.13	9 0.30	247 4.05	85 1.77	37 1.05	2 0.03	0.4	0.1	435	240	34
4S/1W25M1	5 -27-65	385	7.8	48 2.40	3 0.28	29 1.26	3 0.08	0 ---	183 3.00	19 0.40	18 0.50	1 0.02	0.4	---	243	134	31
	10- 4-65	330	8.1	46 2.32	4 0.32	28 1.22	1 0.03	0 ---	195 3.20	22 0.46	16 0.45	3 0.05	0.7	0	255	132	31
	5 -17-67	405	7.9	49 2.43	6 0.51	25 1.10	2 0.06	--- ---	193 3.16	25 0.53	15 0.42	0.4 ---	0.7 0.04	0.10	179	147	---
	11- 5-70	420	7.8	54 2.72	6 0.48	31 1.35	5 0.13	0 ---	220 3.60	26 0.54	20 0.55	2 0.03	0.2	0.1	270	160	29
4S/1W25N1	4 -25-63	379	7.9	54 2.70	3 0.25	21 0.90	2.7 0.07	0 0	177 2.90	21 0.44	14 0.40	1.6 0.025	0.2 0.008	0.02	213	148	19
	10-22-65	360	7.7	51 2.56	4 0.32	26 1.13	2 0.05	0 ---	177 2.90	27 0.56	14 0.40	7 0.11	0.2	0.1	244	144	28
	4 -18-67	376	7.6	50 2.50	4 0.31	25 1.09	2 0.04	0 0	171 2.80	26 0.54	15 0.42	6.2 0.10	0.5 0.03	0.18	206	140	---
	12- 2-68	400	7.25	42 2.10	6 0.52	14 0.59	2 0.05	--- ---	140 2.30	10 0.21	19 0.54	9 0.15	0.23 0.01	Tr.	251	131	---
4S/1W25Q1	11-25-68	405	7.4	46 2.30	5 0.41	17 0.75	2 0.05	--- ---	144 2.34	7 0.15	35 0.99	4 0.06	0.42 0.02	Tr.	242	139	---
4S/1W26C1	9 - -65	360	7.9	42 2.08	8 0.64	24 1.04	3 0.08	0 ---	186 3.05	21 0.44	14 0.40	4 0.06	0.8 ---	0.2	238	136	27

State Well No.	Date Sampled	$EC\times10^6$ at 25°C	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$	Percent Na
				Parts per Million Milligrams Equivalents per Liter													
4S/1W26C1	11-18-68	620	7.65	78 3.89	8 0.69	23 1.00	5 0.12	--- ---	178 2.92	84 1.75	28 0.79	2 0.03	0.26 0.01	Tr.	394	230	---
4S/1W26C3	12- 2-68	450	7.0	44 2.20	6 0.50	23 1.00	4 0.10	--- ---	146 2.39	18 0.37	32 0.90	5 0.08	0.35 0.02	Tr.	292	135	---
	1 -19-70	595	7.4	63 3.15	10 0.85	35 1.50	4 0.10	0 0	174 2.84	24 0.50	52 1.47	19 0.31	0.20 0.01	Tr.	405	200	---
	11- 5-70	600	7.6	74 3.68	7 0.64	44 1.91	5 0.13	0 ---	220 3.60	45 0.94	53 1.50	2 0.03	0.2	0.1	366	216	30
4S/1W26C4	11-18-68	1060	7.45	122 6.10	20 1.67	29 1.25	9 0.22	--- ---	251 4.12	141 2.93	78 2.20	Tr.	0.30 0.02	Tr.	666	380	---
	6 -25-69	1080	7.6	123 6.15	21 1.69	46 2.00	8 0.20	0 0	256 4.20	154 3.21	88 2.48	2 0.03	0.47 0.02	Tr.	722	392	---
	1 -19-70	995	7.4	126 6.30	26 2.15	35 1.50	6 0.15	0 0	248 4.06	154 3.21	98 2.76	4 0.06	0.57 0.03	Tr.	701	423	---
	11- 5-70	980	7.8	136 6.80	17 1.40	45 1.96	5 0.13	0 ---	281 4.60	130 2.71	91 2.55	2 0.03	0.4	0.1	637	410	9
4S/1W26D4	5 -13-69	480	7.0	55 2.75	14 1.17	16 0.70	2 0.05	0 0	202 3.31	13 0.27	26 0.73	Tr.	0.50 0.03	Tr.	300	196	---
4S/1W26D5	5 -13-69	480	6.9	55 2.75	14 1.17	16 0.70	2 0.05	0 0	183 3.00	33 0.69	24 0.68	0 0	0.40 0.02	Tr.	301	196	---
4S/1W26F1	1 - 2-69	545	8.0	72 3.60	8 0.63	23 1.00	3 0.07	--- ---	178 2.92	65 1.35	31 0.87	4 0.06	0.67 0.04	Tr.	397	212	---
	1 -19-70	540	7.2	70 3.50	12 0.96	23 1.00	2 0.05	0 0	176 2.88	58 1.21	40 1.13	11 0.18	0.44 0.02	Tr.	407	224	---
4S/1W26G1	1 -13-61	355	7.7	42 2.10	4 0.33	24 1.04	1 0.03	0 ---	177 2.90	10 0.21	14 0.40	0 ---	---	---	272	122	30

State Well No.	Date Sampled	$ECx10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Per-cent Na
4S/1W26G1	4 -25-63	687	7.6	98 4.90	11 0.90	31 1.35	3.5 0.09	0 0	253 4.15	64 1.33	34 0.95	41 0.66	0.03 0.002	0.02	450	290	19
	10-22-65	310	7.7	40 2.00	3 0.24	25 1.09	2 0.05	0 ---	165 2.70	15 0.31	14 0.40	0 ---	0.3	0.2	212	112	32
	11- 1-66	340	8.0	42 2.08	3 0.24	25 1.09	3 0.08	0 ---	146 2.40	20 0.42	21 0.60	0 ---	0.4	0.4	221	116	31
	11-21-68	400	7.5	48 2.40	6 0.50	19 0.84	4 0.09	--- ---	148 2.43	33 0.69	20 0.56	4 0.06	0.16 0.01	Tr.	270	145	---
	6 -25-69	420	7.6	52 2.60	9 0.77	14 0.60	2 0.05	0 0	148 2.43	37 0.77	26 0.73	1 0.02	0.43 0.02	0	298	169	---
	1 -19-70	510	7.2	66 3.30	10 0.78	12 0.50	2 0.05	0 0	162 2.66	35 0.73	28 0.79	Tr.	0.25 0.01	Tr.	321	204	---
	11- 5-70	465	7.9	64 3.20	6 0.48	30 1.30	5 0.13	0 ---	229 3.75	39 0.81	23 0.65	1 0.02	0.2	0.1	301	184	25
4S/1W26G2	10-22-65	330	7.8	42 2.08	3 0.24	26 1.13	2 0.05	0 ---	180 2.95	13 0.27	14 0.40	0 ---	0.4	0.1	215	116	32
	5 -17-67	513	7.9	68 3.37	9 0.77	23 1.00	2 0.05	--- ---	195 3.20	74 1.55	20 0.56	0.4 0.01	0.3 0.02	0.21	266	207	---
	11-21-68	575	7.4	74 3.70	8 0.69	16 0.71	3 0.07	--- ---	157 2.58	55 1.14	37 1.04	21 0.34	0.13 0.01	Tr.	382	219	---
4S/1W26G3	10-22-65	520	7.6	67 3.36	6 0.48	30 1.30	4 0.10	0 ---	201 3.30	52 1.08	28 0.80	2 0.03	0.2	0.2	320	192	25
	1 - 2-69	1240	7.8	156 7.81	32 2.64	32 1.40	10 0.25	--- ---	306 5.02	204 4.25	73 2.06	31 0.50	0.66 0.03	Tr.	836	523	---
	1 -10-69	1300	7.8	167 8.35	30 2.45	47 2.05	10 0.25	4 0.13	288 4.73	220 4.57	76 2.14	49 0.79	0.66 0.03	Tr.	867	540	---

State Well No.	Date Sampled	$ECx10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter									F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Per-cent a
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3					
4S/1W26J1	7 -15-58	402	8.4	48 2.40	6 0.50	26 1.24	---	12 0.40	171 2.80	20 0.42	21 0.60	0	0.05	0.2	304	145	30
	11-18-58	390	8.1	44 2.20	7 0.58	29 1.26	---	6 0.20	183 3.00	16 0.33	18 0.50	0	0.15	0.1	---	139	31
	6 - 3-59	377	8.2	42 2.10	6 0.50	28 1.22	---	12 0.40	168 2.75	15 0.31	21 0.61	0	0.25	0.2	---	130	32
	10- 2-59	394	7.9	48 2.40	3 0.25	26 1.13	---	0	189 3.10	15 0.31	18 0.50	0	0.3	0.1	---	133	30
	4 -27-60	457	8.0	42 2.10	7 0.58	28 1.22	3 0.08	6 0.20	159 2.60	10 0.21	39 1.10	0	0.2	0.4	---	134	31
	6 -22-61	359	8.3	43 2.15	1 0.08	30 1.30	3 0.08	15 0.50	153 2.50	10 0.21	11 0.30	0	0.3	0.2	---	112	36
	12- 6-61	372	8.3	48 2.40	4 0.33	24 1.04	4 0.10	15 0.50	153 2.50	20 0.42	18 0.50	0	0.3	0	---	136	27
4S/1W26J2	7 - 9-56	382	---	41 2.05	7 0.58	28 1.28	---	6 0.20	165 2.70	15 0.31	14 0.40	---	0.15	Tr.	276	132	31
	7 - 3-57	379	8.1	45 2.25	4 0.33	28 1.28	---	0	186 3.05	20 0.42	14 0.40	0	0.35	0.25	---	129	32
	1 -29-58	348	8.3	42 2.10	8 0.65	26 1.13	---	8 0.25	159 2.60	20 0.42	18 0.50	0	0.15	Tr.	---	139	29
	11-25-58	389	7.9	46 2.30	4 0.33	28 1.22	---	0	183 3.00	15 0.31	21 0.60	0	---	Tr.	---	132	31
	10-29-62	358	8.1	42 2.08	3 0.28	21 0.91	2 0.05	0	155 2.55	15 0.31	14 0.40	0	0.1	0	---	118	27
4S/1W26L1	6 -25-69	1100	7.4	122 6.10	18 1.50	52 2.25	10 0.25	0	456 7.47	55 1.14	54 1.52	0	0.55 0.03	Tr.	782	380	---

State Well No.	Date Sampled	$EC \times 10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Per-cent Na
4S/1W26L3	5 -13-69	400	7.2	44 2.20	2 0.15	20 0.85	2 0.05	0	127 2.08	16 0.33	20 0.57	Tr.	0.30 0.02	Tr.	252	118	---
4S/1W26R1	3 -24-69	960	7.8	121 6.04	15 1.26	42 1.82	10 0.25	0	203 3.32	60 1.24	96 2.70	59 0.95	0.46 0.02	0	615	365	---
4S/1W35A4	9 -14-59	304	8.0	30 1.52	7 0.54	20 0.87	2.6 0.07	0	153 2.51	0	13 0.35	0	0.18 0.01	0	221	103	29
	6 -17-68	296	8.3	37 --	5.2 --	21 --	2.6 --	0	160 2.62	8.2 0.17	9.6 0.27	1.0 0.02	0.3 0.02	0	168	114	---
4S/1W35G1	10-19-59	367	7.1	21 0.92	4 0.29	21 0.92	2.8 0.07	0	160 2.63	4 0.09	15 0.42	0	0.08 0.01	0.26	252	115	28
	3 -26-62	340	7.6	43 2.14	5 0.44	21 0.90	2.8 0.07	0	166 2.72	12 0.24	17 0.47	0	0.4 0.02	0.03	190	129	25
	4 -23-63	298	8.1	34 1.70	3.9 0.32	20 0.87	3.2 0.08	0	163 2.66	2.8 0.06	10 0.28	2.5 0.04	0.35 0.02	0	190	101	29
	12-20-66	306	7.9	37 1.85	4 0.37	20 0.85	3 0.08	0	165 2.70	5 0.11	13 0.38	2 0.03	0.2 0.01	0.01	190	111	27
	12- 6-67	338	8.1	33 1.65	11 0.91	21 0.92	4 0.10	0	184 3.02	9 0.19	13 0.37	1 0.01	0.8 0.04	0	201	128	26
	7 -18-68	305	8.0	38 1.90	4 0.32	20 0.88	3 0.07	---	162 2.66	8 0.16	12 0.34	0	0.30 0.02	0	162	111	28
	7 -28-69	303	8.3	39 1.95	3 0.25	21 0.91	6 0.16	---	159 2.60	7 0.14	12 0.34	0	0.45 0.02	0	---	110	28
4S/1W36A1	3 -27-63	394	8.2	48 2.40	5 0.40	22 0.96	2 0.05	9 0.30	171 2.80	17 0.35	16 0.45	0	0.04	---	243	140	25
	10-22-65	340	7.7	46 2.32	6 0.48	26 1.13	1 0.03	0	186 3.05	14 0.29	18 0.50	0	0.3	0.1	243	140	29

State Well No.	Date Sampled	$EC\times10^6$ at 25°C	pH	Parts per Million Milligrams Equivalents per Liter									P ppm	B ppm	Total Dissolved Solids	Total Hardness as $CaCO_3$ ppm	Percent Na
				Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3					
4S/1W36A1	4 -18-67	251	7.4	40 2.00	4 0.34	21 0.92	1 0.02	0	162 2.65	10 0.21	15 0.43	0.4 0.01	0.4 0.02	0.12	125	117	---
	11-21-68	410	7.4	34 1.70	10 0.85	21 0.91	4 0.09	---	146 2.40	12 0.25	26 0.73	0	0.16 0.01	0	272	127	---
4S/1W36A2	11-18-68	400	7.5	48 2.40	5 0.38	16 0.71	4 0.09	---	138 2.27	35 0.73	21 0.59	0	0.26 0.01	0	253	139	---

APPENDIX NO. 6

GROUNDWATER ELEVATION AT SELECTED WELLS

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Wells in the Upper San Jacinto Groundwater Basin are identified utilizing the numbering system used by the California State Department of Water Resources, according to township, range and section. (All of the wells are referenced to the San Bernardino Base and Meridian as the points of origin) Under this system each section is divided into 40-acre parcels which are lettered as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Wells are numbered within each of the 40-acre parcels according to the order in which they are located. For example, the well having the number 4S/1W - 25G1 would be found in Township 4 South, Range 1 West and in Section 25 San Bernardino Base and Meridian. It is further identified as the first well located in the 40-acre parcel lettered G, which is the southwest quarter of the northeast quarter of Section 25.

Locations of the wells listed in this appendix are depicted on Figures 13 and 46, entitled "Well Location Map", which are found in Volume 1 of this report.

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Well No.	R. P. Elevation	Date	Depth to Groundwater	Groundwater Surface Elevation
4S/1W - 23K2	1541.8	11/1/68	100.0	1441.8
		4/4/69	92.9	1448.9
		4/29/70	109.6	1432.2
4S/1W - 23L1	1534	5/19/65	60.0	1474.0
4S/1W - 23N2	1539.2	10/15/65	174.0	1365.2
		11/19/65	167.0	1372.2
		11/29/67	169.0	1370.2
		4/4/69	174.2	1365.0
		2/3/70	153.0	1386.2
4S/1W - 23P1	1541.2	5/19/65	146.0	1395.2
		11/19/65	150.0	1391.2
		3/7/67	149.0	1392.2
		10/29/68	154.8	1386.4
		4/21/69	155.5	1385.7
		2/3/70	154.3	1386.9
4S/1W - 23P2	1540.0	10/29/68	53.4	1486.6
		4/21/69	40.8	1499.2
4S/1W - 23P4	1540.6	10/15/65	174.5	1366.1
		2/16/66	171.0	1369.6
		11/29/67	171.0	1369.6
		10/29/68	185.3	1355.3
		4/4/69	175.5	1365.1
4S/1W - 23P5	1544	11/1/68	41.4	1502.6
		4/1/69	39.0	1505.0
		2/3/70	38.3	1505.7
4S/1W - 23P7	1542.0	10/29/68	34.3	1507.7
		4/21/69	32.5	1509.5
4S/1W - 23Q3	1546.1	5/19/65	162.0	1384.1
		10/15/65	169.0	1377.1
		5/17/67	172.0	1374.1
		11/1/68	181.0	1365.1
		4/2/69	178.0	1368.1
4S/1W - 23Q4	1542.8	5/19/65	152.5	1390.3
		2/15/66	154.0	1388.8
		11/29/67	157.5	1385.3
		11/1/68	180.6	1362.2
		4/4/69	179.2	1363.6
		4/23/69	168.1	1374.7
		1/27/70	162.3	1380.5
		2/2/71	149.0	1393.8

Well No.	R. P. Elevation	Date	Depth to Groundwater	Groundwater Surface Elevation
4S/1W - 23Q6	1544.0	11/6/68	31.9	1512.1
		4/1/69	28.4	1515.6
4S/1W - 23F1	1547.7	5/19/65	Dry @ 180	
		2/15/66	181.0	1366.7
		11/1/68	198.6	1349.1
		3/27/69	195.9	1351.8
		4/7/70	196.0	1351.7
		2/2/71	194.5	1353.2
4S/1W - 25D2	1559.0	3/7/67	198.0	1361.0
		10/29/68	235.2	1323.8
		3/27/69	225.0	1334.0
		4/23/69	195.9	1363.1
		4/13/70	181.1	1377.9
		2/2/71	197.2	1361.8
4S/1W - 25E1	1568	1/7/42	10.6	1557.4
		1/16/45	25.3	1542.7
		1/10/50	77.5	1490.5
		5/8/52	105.9	1462.1
		10/17/52	122.2	1445.8
		6/12/53	117.3	1450.7
		9/16/53	122.5	1445.5
		1/7/55	127.5	1440.5
		3/19/68	116.5	1451.5
		4/17/68	114.6	1453.4
		4/25/69	114.9	1453.1
4S/1W - 25G1	1570.0	5/11/65	211.0	1359.0
		11/19/65	196.0	1374.0
		4/19/68	189.0	1381.0
		11/1/68	193.0	1377.0
		4/17/69	188.3	1381.7
4S/1W - 25M1	1570.9	5/20/65	200.0	1370.9
		2/15/66	208.0	1362.9
		11/29/67	216.5	1354.4
		10/28/68	222.2	1348.7
		4/17/69	217.4	1353.5
4S/1W - 25N1	1583.0	1/4/68	240.9	1342.1
		4/17/69	236.1	1346.9
4S/1W - 26C1	1544.6	5/19/65	168.0	1376.6
		4/21/69	176.4	1368.2
4S/1W - 26C2	1548.5	10/31/68	183.9	1364.6
		4/4/69	181.8	1366.7
		2/3/70	183.7	1364.8
		4/9/70	179.0	1369.5

Well No.	R. P. Elevation	Date	Depth to Groundwater	Groundwater Surface Elevation
4S/1W - 26C3	1548.0	4/4/69	91.0	1457.0
		2/3/70	85.1	1462.9
		4/9/70	89.0	1459.0
4S/1W - 26C4	1543.8	11/4/68	154.5	1389.3
		4/25/69	160.3	1383.5
		2/17/70	134.3	1409.5
4S/1W - 26C6	1543.8	11/4/68	176.0	1367.8
		4/25/69	175.1	1368.7
		2/17/70	176.1	1367.7
4S/1W - 26D3	1538.0	10/29/68	120.9	1417.1
		4/25/69	104.0	1434.0
		2/17/70	92.5	1445.5
4S/1W - 26D4	1533.0	4/14/69	48.7	1484.3
		2/17/70	46.6	1486.4
4S/1W - 26D5	1534.0	11/12/68	40.9	1493.1
		4/8/69	39.2	1494.8
4S/1W - 26D9	1537.5	4/21/69	84.5	1453.0
		2/17/70	83.8	1453.7
4S/1W - 26D11	1532.5	4/14/69	42.4	1490.1
		2/17/70	41.1	1491.4
4S/1W - 26E3	1544.0	10/29/68	103.3	1440.7
		4/21/69	97.5	1446.5
		2/17/70	72.1	1471.9
4S/1W - 26G1	1550.0	10/31/68	190.3	1359.7
		4/25/69	190.4	1359.6
4S/1W - 26G2	1555.5	5/19/65	182.0	1373.5
		11/19/66	181.5	1374.0
		3/7/67	183.0	1372.5
		10/31/68	194.3	1361.2
		4/25/69	190.0	1365.5
4S/1W - 26G3	1555.6	10/15/65	64.0	1491.6
		11/13/68	173.1	1382.5
		1/4/69	161.1	1394.5
4S/1W - 26J1	1574.5	5/20/65	196.0	1378.5
		10/15/65	199.5	1375.0
		3/7/67	203.0	1371.5
		10/28/68	218.0	1356.5
		4/19/69	210.0	1364.5
		3/24/70	210.0	1364.5

Well No.	R. P. Elevation	Date	Depth to Groundwater	Groundwater Surface Elevation
4S/1W - 26J2	1570.6	10/15/65	196.5	1374.1
		2/15/66	197.0	1373.6
		5/13/67	201.0	1369.6
		10/29/68	208.0	1362.6
		4/17/69	211.0	1359.6
		3/24/70	210.0	1360.6
		4/9/70	211.0	1359.6
4S/1W - 26L3	1551.7	11/6/68	190.6	1361.1
		3/24/70	205.6	1346.1
4S/1W - 26M2	1548.0	5/6/68	182.1	1365.9
		7/1/68	187.3	1360.7
		9/4/68	184.5	1363.5
		11/6/68	182.1	1365.9
		4/21/69	180.3	1367.7
		3/18/70	182.4	1365.6
4S/1W - 26Q1	1567.5	12/4/68	206.9	1360.6
		5/19/70	208.3	1359.2
4S/1W - 26R1	1571.0	11/26/68	53.4	1517.6
		4/17/69	54.5	1516.5
		3/24/70	46.6	1524.4
4S/1W - 36A1	1593.0	4/17/69	277.9	1315.1
4S/1W - 36A2	1597.5	10/31/68	304.5	1293.0
		4/17/69	288.3	1309.2
		2/2/71	281.4	1316.1
4S/1W - 36D1	1584.0	11/4/68	247.7	1336.3
		4/17/69	243.5	1340.5